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apoc

NOVEMBER 2023 #525

YOUR EXPERT GUIDE TO TODAY'S TECH



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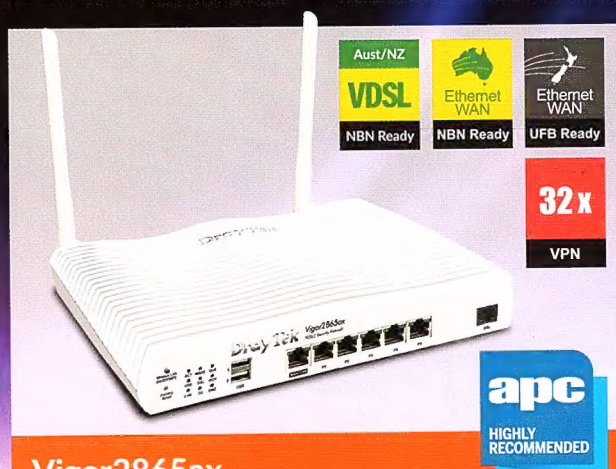


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Vigor2765ax

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Vigor2135ax

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Printed in Australia by IVE

Distributed in Australia and NZ by Are Direct

ISSN 0725-4415

Future Publishing Australia
PO Box Q1179, Queen Victoria Building, NSW 1230
Corporate Web: www.futureplc.com
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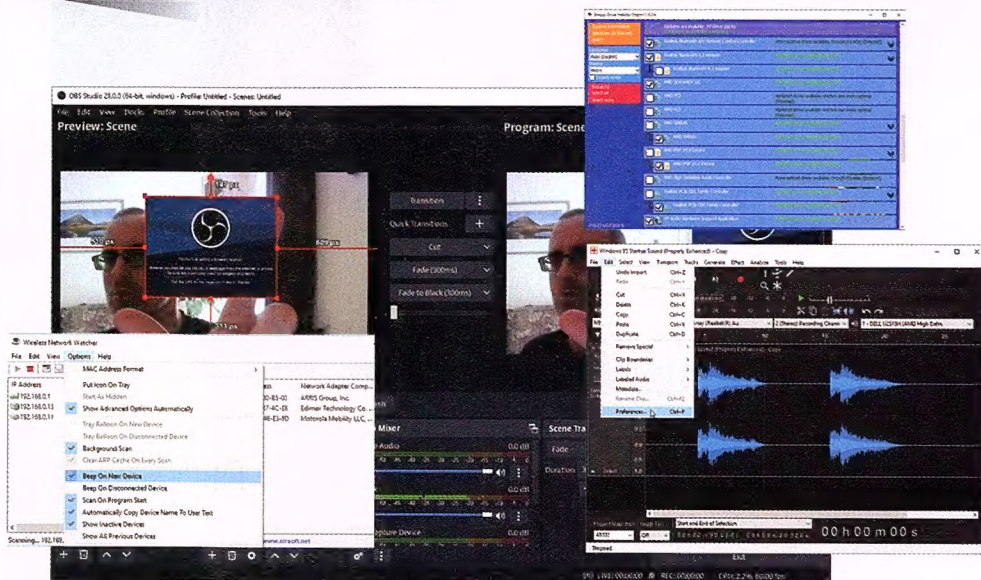
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INTRO

EDITORIAL

WHAT'S INSIDE APC



EDITORIAL

Do more Pay nothing



BEN MANSILL
Is wondering if it's time to replace his CPU coolant fluid.

"Finding good free apps is a tricky business now. There are so many traps, and honestly it's hard to know what the best option is from what used to be a simple Google search."

PCs have always benefitted greatly from cool free software. I think it's fair to say we all have our 'essentials' list that we install after setting up a new PC. The little apps that do big things, and do them better than the OS does. Like IrfanView, which has been a personal favourite for image processing since the very early 2000s. Or LibreOffice for local docs. These are the apps I can't do without, but it's getting harder to find good ones you can trust anymore.

That's the point of the guide we've worked on this month for you. To create a list of all the good apps that do the jobs you want and need – but without any hidden traps. The trend of late towards freemium pricing is annoying, although somewhat understandable. Most freemium apps are up-front enough about what you get and don't get, but being locked out of the nicest features kind of spoils the whole spirit of the PC appeal of these.

I understand that devs need to make a living, and while the free apps we're covering here are capable of doing a huge range of tasks, full paid versions are almost always a slicker package. Those are the money-spinners for most devs, but for an app with a small but very focussed set of functions free can be the winning way. Most of these smaller apps will accept donations, and I give a few dollars when something pleases me and I feel that I've been using it long enough that I feel compelled to make a small conscious-clearing donation via PayPal. I do that too, with the community radio stations I often listen to. It's fair and right, and in a way makes you part of the operation's success.

Finding good free apps is a tricky business now. There are so many traps, and honestly it's hard to know what the best option is from what used to be a simple Google search. The rankings are now so polluted by paid results that it's a waste of time to rifle through what seems like the best choices, read a few reviews, and then download and install only to find there's the usual locked out features, advertising bombardments and the real risk of malware.

But don't you worry about all that, Team APC knows where the gold lies. Head over to our guide on page 52 and load up on the good stuff so you and your PC can do more, without a worry.

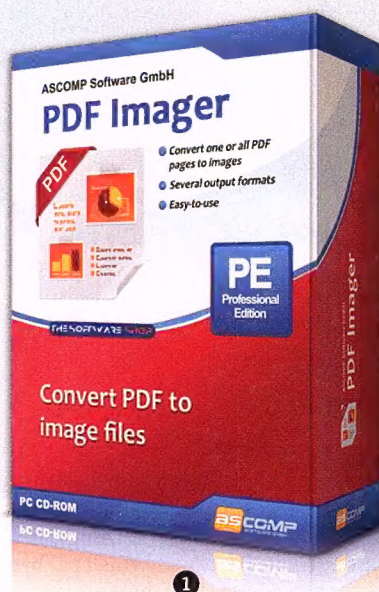
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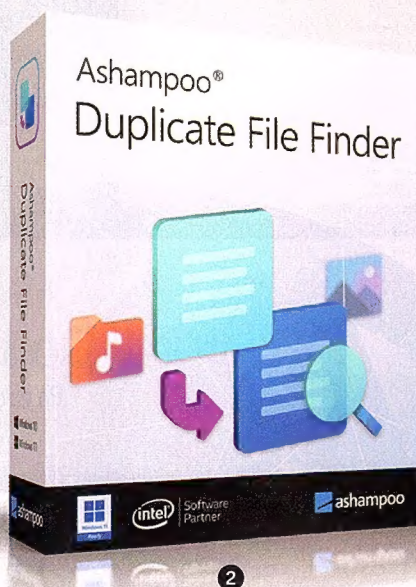
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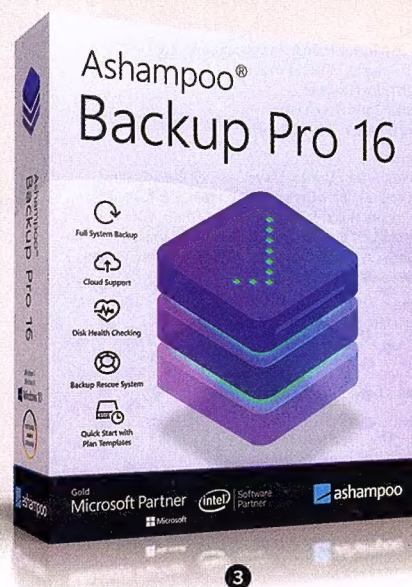
2

ASHAMPOO DUPLICATE FILE FINDER

Find and delete duplicate files safely.

Your PC is very likely littered with duplicate files that often occupy massive amounts of disk space. This may be photos but also files related to program installations or even Windows itself. You cannot delete these files without risk unless you have Ashampoo Duplicate File Finder! That's because many programs will stop working when you delete their files. It takes smart technology to get it right: Ashampoo Duplicate File Finder not just deletes file duplicates but keeps a master file and replaces all others with internal links to that file. This means your programs won't know the difference and will work as expected.

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3

ASHAMPOO BACKUP PRO 16

Comfortable handling and supreme data security.

Ashampoo Backup Pro 16 takes the fear out of viruses, ransomware and hardware errors! Experience an easy to use well-designed but powerful backup solution. The new Ashampoo Backup Pro 16 offers you all possible storage options: Back up single files to entire partitions to local drives or online storage providers. In addition, the program is light on resources, gets out of your way and does all the heavy lifting in the background. Naturally, it can also restore your backups.

Ashampoo Backup Pro 16 even comes with a bootable rescue system to restore your system in the event of major system failure—including Windows 11 systems!

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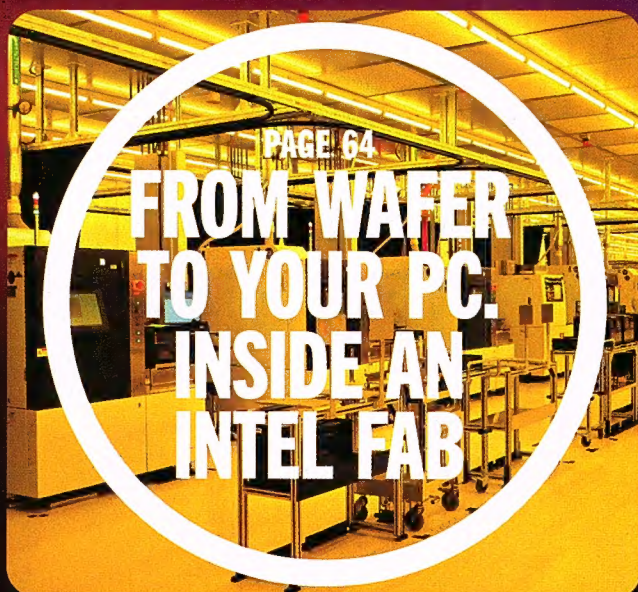
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THE BEST FREE PC SOFTWARE

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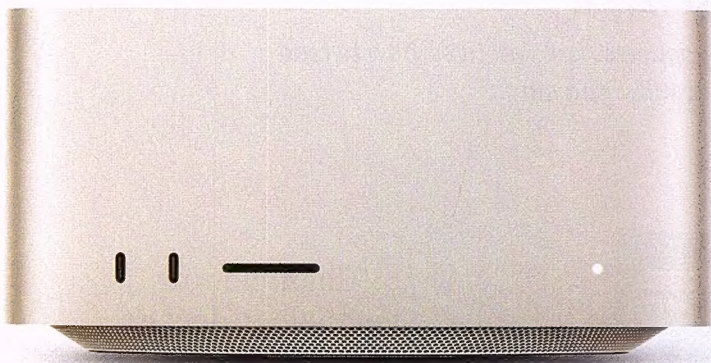
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CLOUD COMPUTING: DRIVING F1 FORWARD?





APPLE MAC STUDIO (M2 ULTRA)

The new Mac Studio promises serious power and connectivity upgrades, but is the update as impressive as the original breakthrough device?

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The less than serious news page



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HOW WE DO IT

Inside APC

Find out all about APC's editorial policies, test practices, how to read the benchmark results, and more.



"Championing technology doesn't mean we're unrelenting yes-men and -women, however, and APC aims to be as objective as possible in all our coverage."

APC is Australia's oldest consumer technology magazine – having been consistently in print for over forty years, since our first issue way back in May 1980 – and we take that heritage and responsibility very seriously. While our focus is obviously on the personal computer the very definition of the PC has changed and shifted markedly since the early 1980s. As such, we touch on many other areas of tech, too, from smartphones and apps to peripherals, accessories, and beyond. We have two goals: to find the best modern tech and to help you make the most of it.

We're also an open church in terms of platforms. We know most people aren't wed to a single brand's products and use a variety of devices. And, like you, APC's journalists want to know what's good in tech – no matter what platform it resides on.

Independent reviews

Championing technology doesn't mean we're unrelenting yes-men and -women, however, and APC aims to be as objective as possible in all our coverage. That means identifying the best products from multiple perspectives – the best performance, best value and best features and, ideally, the products that offer the best mix of these three attributes.

As a matter of policy, reviews published in APC are not shared with product-makers prior to print. We will contact vendors under certain conditions; for example, if we have a problem testing a product that seems to indicate it may be faulty, or to invite a vendor to clarify how a particular feature works. If an APC reviewer has any potential conflicts of interest involving a brand, the review will always be assigned to another writer.

Labs testing

APC strives to conduct the most rigorous, objective scientific tests and benchmarks we can so as to make our reviews as unbiased as possible. We use a variety of tools and programs for this, including many freely available benchmark suites for assessing media encoding, general system performance including storage read and write speeds, gaming and battery life.

In most cases, for the benchmark results published in APC, you can assume that higher is better. There are certain tests that deviate from this rule where the opposite is true; in those cases, we've flagged the results with a note explaining as such.

We use both tables and graphs for displaying results; the latter offers better ease-of-readability, but tables are more compact, so we use these in most cases where thoroughness is preferred.



apc TESTBED

The current APC testbed used in the Labs for benchmarking all components. This testbed is updated as new and relevant technology comes on stream.

CPU	Intel Core i9 12900K
Motherboard	Asus Maximus Z690 Apex
Graphics Card	Nvidia GeForce RTX 4090 Founders Edition
RAM	2x16GB G.Skill Trident Z5 DDR5-6000
Power Supply	Corsair AX1000
Storage	Seagate Firecuda 530 2TB
Case	Thermaltake Core P8
Cooling	Cooler Master Flux PL360 AIO
Operating system	Windows 11 Pro 22H2

apc AWARDS



APC EDITOR'S CHOICE
When a product scores 4.5 out of 5, it carries the Editor's Choice Award. These are products that exceed expectations and deliver a quality experience up there with the very best.



APC HIGHLY RECOMMENDED
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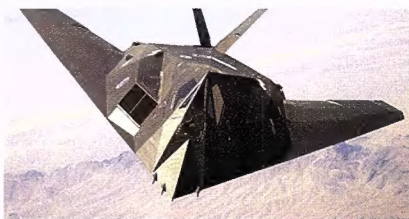


UNITY ISSUES APOLOGY FOR NEW FEE POLICY

PROMISES CHANGES AFTER DEV BACKLASH.

Unity poked a wasps' nest in late September when it presented its new runtime fee policy to users of its popular video games development engine. As Unity is seemingly having some issues with profitability, the central idea in the new policy was to charge games publishers as much as \$0.20 per game install. The fees policy was set to be enacted from January 1, 2024. Already we are seeing the first signs of a Unity U-turn on the despised new runtime fee policy. It remains to be seen how big a change is coming. It is promising that Unity says "We are listening, talking to our team members, community, customers, and partners, and will be making changes to the policy."

© Gunfir



ANOTHER MILITARY LEAK ON THE WAR THUNDER FORUMS THIS KEEPS HAPPENING...

Yet another restricted military document had been posted on the War Thunder forums and removed. Wikipedia's collaborative record-keeping now puts the number of War Thunder forum military document leaks and other incidents at 10. The document in this case is a flight manual for the F-117 Nighthawk. Unlike the first War Thunder forum leak in 2021, which contained classified details about the UK's Challenger 2 tank, the flight manual posted last week is not classified, but online publishing is still not allowed. The Lockheed F-117 Nighthawk was introduced in the '80s and retired by the US Air Force in 2008. A similar incident occurred in August, when someone posted an also non-classified Eurofighter Typhoon DA7 manual on the War Thunder forums.

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Up to 2x GFX performance/watt*
- Deliver AI at Scale ✓
First client integration of AI engine (NPU)

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CHIP TECH

Intel's next-gen Meteor Lake CPUs

A game-changing 40-year architectural shift to rival Apple.

Intel has taken the wraps off its forthcoming next-gen Meteor Lake processors following its successful 12th (Alder Lake) and 13th Gen (Raptor Lake) processors with its new E- and P-core design. Its first chip built on the Intel 4 process node with Foveros 3D packaging, Intel calls Meteor Lake its "biggest architectural shift in 40 years" and that it will "lay the foundation for innovations for the PC."

Meteor Lake processors are expected to ship in late 2023 or early 2024 in new laptops with thinner and lighter designs, better cooling, and much better battery life. The significant change for Meteor Lake is what Intel calls disaggregation, which means the breaking down of core components into separate 'tiles' on the SoC. Meteor Lake features four Tiles, including: Compute Tile: New E-core and P-core microarchitecture, built on Intel 4 process technology; SoC Tile: Low power island E-cores, NPU, Wi-Fi 6E/7, native HDMI 2.1 and 8K HDR AV1 support; Graphics Tile: Integrated Intel Arc architecture; IO Tile: Thunderbolt 4 (and presumably Thunderbolt 5) and PCIe Gen5.

Separating core components ("disaggregating") allows the SoC to turn off certain parts when not used.

For instance, Media IP, including support for playing back video, previously was on the integrated GPU.

Next is the introduction of new low-power island E-cores. Intel Alder and Raptor Lake chips featured E-cores ("efficiency") for lower power functions and P-cores ("performance") for primary ones where more power is needed. Those cores, while improved in

Meteor Lake, have been moved to the new Compute Tile. New and additional low-power island E-cores remain on the SoC Tile. These new E-cores draw even less power and offer a third level of performance, mainly for system background functionality in Windows.

Intel includes a discrete neural processing unit (NPU) on the SoC Tile. This chip offloads AI tasks

like background blurring for webcams, on-the-fly noise removal for microphones, and even localised large language models (LLMs). This frees up all the P- and E-cores for everyday Windows tasks without degradation in performance.

The GPU is also getting a significant overhaul as Intel is porting its Arc GPU technology to Meteor Lake, delivering up to 2x the performance of Iris Xe found in 12th and 13th-generation CPUs.

"Meteor Lake processors are expected to ship in late 2023 or early 2024 in new laptops with thinner and lighter designs, better cooling, and much better battery life."



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Microsoft wants to buy Valve and Nintendo

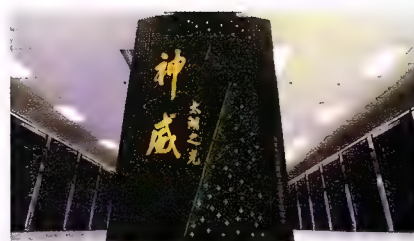
According to leaked docs.

The FTC and Microsoft are presently in court over the FTC's desire to block Microsoft's acquisition of Activision Blizzard, and as seems to happen every time a big gaming company goes to court, there's been an accidental leak of confidential documents.

One of the documents is a 2020 email from Xbox chief Phil Spencer in which he said that Nintendo is the most desirable gaming company Microsoft could acquire. Tucked into the end of that email is the comment that the Microsoft Board of Directors has seen "the full writeup on

Nintendo (and Valve)" and is "fully supportive on either if opportunity arises."

What would Microsoft buying Valve mean for PC gaming, if it happened? We shudder to think of it! As imperfect as it is to rely on competition between giants for security, Valve's independent power has always felt like a check on Microsoft control over PC gaming. Valve built SteamOS on Linux in part as a life raft for PC gaming, should Microsoft ever go too far in locking down Windows, Apple-style.

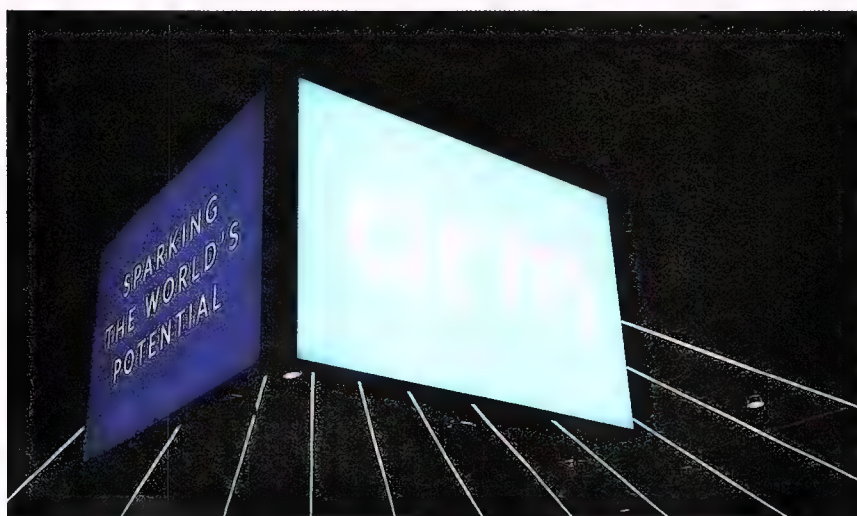


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CHINA MAY HAVE UNMATCHED SUPERCOMPUTER

THIRD EXASCALE MACHINE APPARENTLY ONLINE.

It appears that a third Chinese exascale supercomputer, long thought to be halted indefinitely due to the impact of US sanctions, has come online. Meanwhile, the US currently only has two exascale machines, Frontier and Aurora, in operation. China hasn't officially announced the new machine, likely fearing that it will draw the attention of US regulators, thus triggering more sanctions. The new supercomputer was purportedly made by China-based Sugon, at the National Supercomputing Center in Shenzhen. The company lost access to the Hygon CPUs, a series of China-produced x86 processors based on AMD's Zen design, that it planned to use because US sanctions shut down AMD's joint venture that produced the processors. It's unclear which processors are being used for the machine.



ARM GOES PUBLIC FOR US\$54.5B

Plan B: After the failed Nvidia sale.

Chip designer Arm Holdings is going public for the second time in almost thirty years, this time with a market value of US\$54.5 billion. The company listed 95.5 million shares under "ARM" on Nasdaq, the largest IPO since the electric truck maker Rivian went public in 2021 for over US\$66 billion.

The current share price is US\$51, giving Arm a market capitalisation of roughly US\$54.5 billion. There was early speculation that the IPO value would be as high as US\$70 billion as big tech companies like Amazon, Nvidia, and Intel planned to spend billions of dollars on the chip designer once it went public. "Together, we have built the world's largest compute and software ecosystem based on the most pervasive CPU architecture in history," wrote Rene Haas, CEO of Arm.

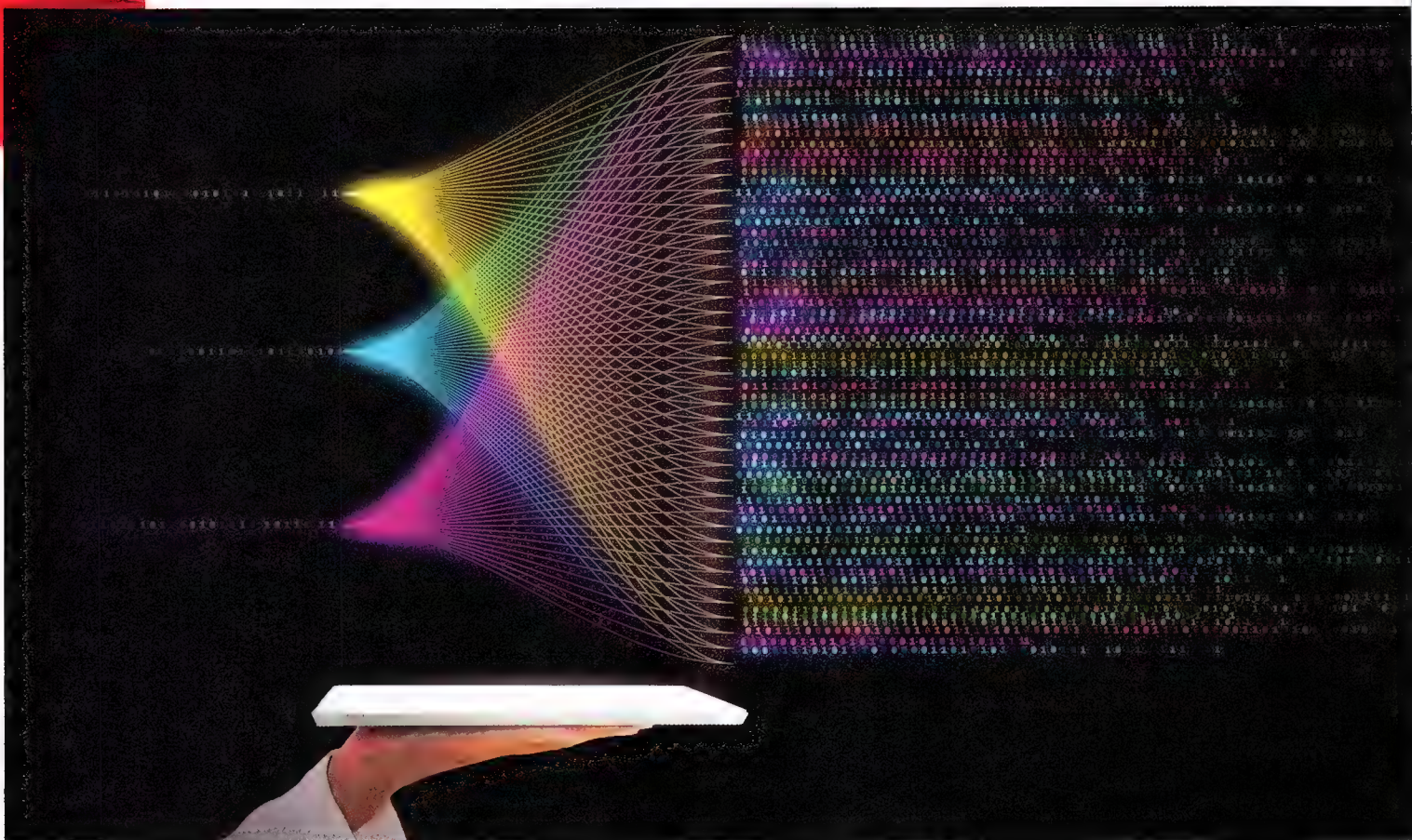


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MICROSOFT PAINT ADDS SOME OF PHOTOSHOP'S BEST FEATURES

POWERFUL ENOUGH TO REPLACE SOME OTHER CREATIVE APPS.

Paint fans rejoice! Microsoft announced plans to add several powerful features to the creative application. Paint will soon support layers, transparency, and feature a background removal tool. These additions should greatly enhance the capabilities of Paint, which is interesting considering Microsoft once planned to move away from the app entirely. The addition of layers fundamentally changes the layout of Paint. Layers are common in other creative apps, such as Adobe Photoshop. They aren't a new concept, but they're essential for many types of work. For example, you can stack layers containing different images on top of each other. Layers wouldn't be that useful without transparency support, so it makes sense that Microsoft will roll out the additions alongside each other. ■



TECH BRIEF

Is quantum computing ready for prime time?

It's no longer just science fiction – Steve Cassidy asks whether it's time for businesses to make the quantum leap.

We're hearing more and more about quantum computing, and you might be starting to wonder what value it could have for your business. The answer is far from clear, because good, practical information about this new frontier is hard to come by.

While the nascent technology might not be about to transform every computing task, I've had some conversations in the past year that suggest it's time for businesses to start thinking about potential real-world quantum applications. That primarily means processes that involve performing analysis or computation on large data sets.

For example, George Gesek, CTO at quantum specialist QMWare, gives the example of vehicle testing: when large manufacturers put their designs through the full range of product-testing procedures, they get back over

260 distinct statistics, settings, results and predictions per vehicle. Some of those 260 data items might be single number results, while others might be n-dimensional plots of fuelling maps versus programmed power output management. Finding correlations and combinations of these values via conventional computing is intensive, repetitive and slow; a quantum-based approach could do the same work in the blink of an eye.

Another discussion involved a certain American supermarket chain, and its habit of offering discount coupons. The question here was whether combinations of discount schemes might push the retailer into making a loss, and finding the answer was harder than you might think: coupons are a universe of fancifully ephemeral, limited data all to themselves. They can be local, global,

time limited, product limited, modified by qualifying buyer, brand, age group... the number of permutations rises even more rapidly than the number of data points in the car-testing example, making it another ideal candidate for the strengths of quantum.

As well as analysing static data sets, quantum computing can be useful for modelling complex systems such as financial investment portfolios, and the chaotic markets in which they operate. In chemical research, quantum analysis can simulate interactions between molecules far more efficiently than any current computer system. Amid all the wide-eyed talk of universes, infinities, and criminal masterminds, there are proper business benefits to be reaped, especially for forward-thinking companies that embrace the potential of QC ahead of their rivals.

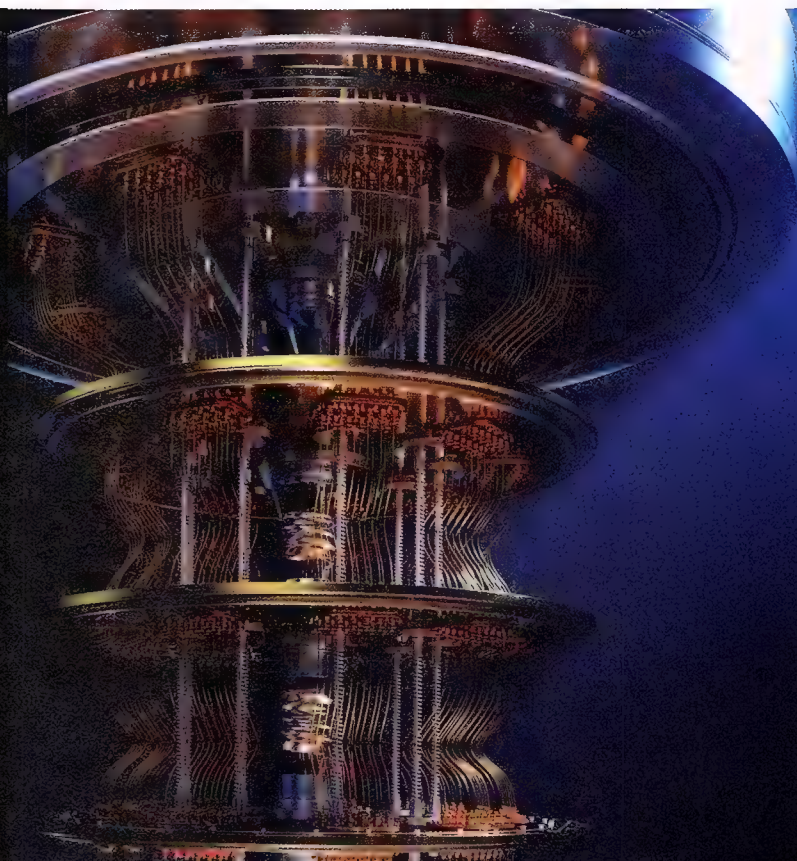
Quantum resources

Even though quantum could be the next computing revolution, you'll

"The only way for most humans to get access to a QC CPU is to lease access via a hybrid cloud architecture, from a supplier such as Amazon, IBM, Google or Microsoft."



Above: Quantum computers such as this one in Germany need room-filling cooling.
Above right: Quantum computers may look like sci-fi inventions, but they're now reality.



have noticed that nobody's blowing up your phone to try to sell you a quantum computer. In fact, it's doubtful whether on-premises quantum computing will be a reality within the next decade.

That's because, while these machines have many similarities to regular electronic computers, the emergent state of the technology is such that they're vastly more expensive to build – I've seen prices of \$15 million per unit quoted. They're also a lot harder to install and operate, thanks to the awkward fact that separating the results of your QC computations from the background noise of the universe requires the core components to be kept a few degrees above absolute zero – that is, around -270°C . So while the processing hardware might be no larger than your average pedestal server, the cooling apparatus is liable to fill a room, and to consume more energy than the rest of your business put together.

In practice, then, the only way for most humans to get access to a QC CPU is to lease access via a hybrid cloud architecture, from a supplier such as Amazon, IBM, Google or Microsoft. This allows you to stay cosily unfrozen at home, while your code runs in a data centre located in some ice-dripping cavern above the

Arctic Circle. Existing and well-understood mechanisms keep the cloud copy and your on-premises versions in sync; the difference is that the cloud version is reachable by the quantum CPU, while your stay-at-homes are not.

The cost of quantum

That brings us to the next potential obstacle to widespread QC adoption: quantum access is expensive. The precise cost depends entirely on the tasks you're running, but you can be sure that we're not talking here about the everyday hosted services that run your website and a WordPress plugin or two.

It's not just the cost of the compute cycles, either. You may be used to the idea of a hybrid IT estate entailing extra costs to mix up the local resources with the hosted cloud stuff, but to take advantage of QC you need to go beyond a conventional hybrid outlook. You have one complete copy of your definitive business data lake held locally, and another up there where the supercooled chips can get at it, so you can run any and all of your apps, database services, third-party connectors and the like within the purview of the QPU. This is about the most expensive hybrid model possible.

Maybe things will get better as fibre speeds increase: in the future it may be possible to

"invite" a cloud QPU to "visit" your data. Right now, though, the use cases in which a fully hybridised data estate actually pays its way are firmly over at the super-sized end of the business spectrum.

The best way to achieve efficiency improvements may be by targeted simplification. Quantum computing is the ideal model for, for example, analysing a complete record of the behaviour of all airmasses bordering the Atlantic for the past century – but that's probably overkill you're just wanting to know if it's going to be nice out today.

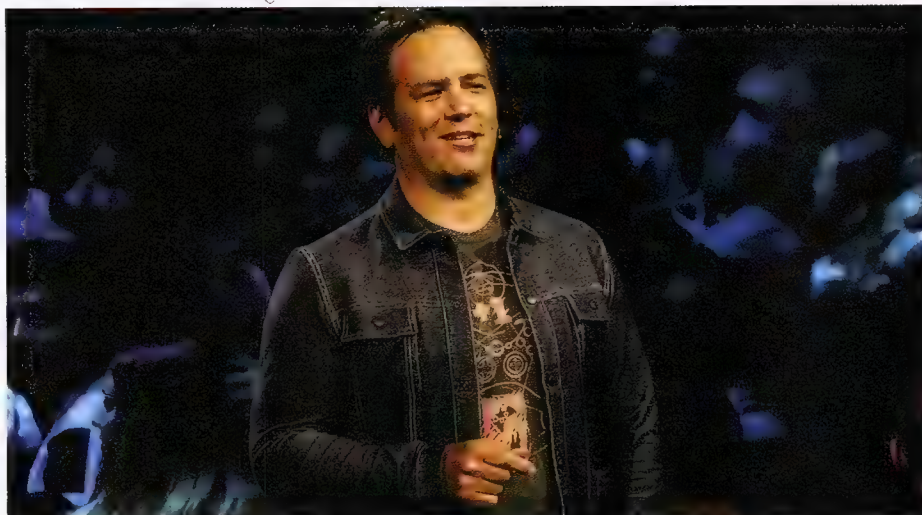
As organisations refine the scope of the data they deliver into the hybrid space, it should be possible to reduce the required scale of quantum operations.

It'll be clear by now that, while quantum capacity is no longer a mere sci-fi concept, there's a lot to work out before the technology can really be called mainstream. Indeed, as in the early days of AI, the majority of supposedly "quantum" products and services popping up in the near future are likely to be nothing of the sort. But if you have an intractable modelling problem or a lot of data to pre-test for regulators, QC has the potential to provide immense gains – and you can start working on the code right now. ■ **Steve Cassidy**

END USER

Big Microsoft leak reveals a company anxious about its games future

Nintendo and Valve aren't too big to acquire for Xbox, but what if the acquisitions spree runs dry? Asks Shaun Prescott.



Shaun is an Australian editor for *PC Gamer*, *GamesRadar* and *PLAY*, and writes for *APC*, *TechRadar* and more.

Last month Microsoft inadvertently leaked troves of internal communications related to its Xbox business, thanks to an accidental exchange of unredacted documents with the Federal Trade Commission. Its revelations are abundant, though perhaps unsurprising: the documents include references to a 2024 mid-gen refresh of the Xbox Series X and a new DualSense-inspired Xbox gamepad, to name two examples.

A 2020 presentation contained in the leaks made reference to unannounced projects like *Dishonored 3*, *Ghostwire: Tokyo 2* as well as *Oblivion* and *Fallout 3* remasters. These should be taken with a hint of scepticism because software pipelines are hugely beholden to change: the *Oblivion* remaster was meant to release during fiscal year 2022, for example, but has yet to materialise or even be announced.

These details are interesting, though again, it's hard to know how much has changed. The most interesting revelation relates to the Xbox business's gung-ho approach to acquisitions. During the last decade Microsoft has acquired Zenimax Media (Bethesda), Mojang (*Mineraft*), and perhaps most famously, is currently in the process of acquiring games behemoth Activision Blizzard, which owns some of the most popular games franchises in the world including *Call of Duty*, *World of Warcraft*, and a host of obscenely

popular phone games you probably haven't heard of.

Xbox lead Phil Spencer wants more, though. In a 2020 email, Spencer described Nintendo as "THE prime asset" (emphasis his), and refers to a possible acquisition of the legendary Japanese company as "a long game". Spencer says that he and Microsoft's board of directors are "fully supportive" of the pursuit, and also mentions Valve as a possible target, albeit in parentheses and without any elaboration. "It's just taking a long time for Nintendo to see that their future exists off of their own hardware," Spencer goes on.

That might seem like a bizarre claim given the meteoric success of the Nintendo Switch, and its unique value proposition. But in the context of Spencer's own views of where the future of gaming hardware is headed, it's a little less brash. Spencer has made it very clear that Xbox Game Pass is a platform that transcends the old

console archetype, stretching across PC, the cloud – and yes – consoles as well, though with huge emphasis on expanding the audience across the former two going forward. Going by this logic, it's possible to imagine a console-less world in a decade or so, though that prediction has never gone down well: the console's imminent death was being mourned as far back as the Xbox 360 / PS3 era.

The inherent creative problems of conglomeration aside, what happens if Microsoft acquires basically the whole blockbuster games industry, and then fails? In the days after the Big Leak, an FTC lawyer presented Spencer with a slide showing Microsoft's growth projections for Xbox Game Pass. Without going into the raw numbers, console audiences are expected to be far greater than both native PC and cloud users as far into the future as FY2030. That's bad, for Spencer. "I can fairly safely say that if we do not make more progress than this off of console, we would exit the gaming business," he said, as reported by WCCF Tech.

While that could be interpreted as an appeal for Activision-Blizzard's ownership, it's an interesting statement: does Microsoft need to own everything to brute force a post-console games industry? Is this revolution reliant on every important publisher and studio being aboard the same ship? What is clear, is that Microsoft wants to own gaming, in the same way Spotify owns music or Netflix used to own screen streaming. While Sony and Nintendo continue to rely on their own strong IP and development pipeline, Microsoft is taking a rougher, more dogged approach to dominance. ■

From: Phil Spencer </O=EXCHANGELABS/OU=EXCHANGE ADMINISTRATIVE GROUP (FYDIBOHF23SPDLT)/CN=RECIPIENTS/CN=MICROSOFT.ONMICROSOFT.COM-55760-PHIL.SPENCER>
To: Chris Capossela; Takeshi Namoto
Sent: 8/6/2020 12:03:02 AM
Subject: RE: random thought

Takeshi, I totally agree that Nintendo is THE prime asset for us in Gaming and today Gaming is our most likely path to consumer relevance. I've had numerous conversations with the LT of Nintendo about tighter collaboration and feel like if any US company would have a chance with Nintendo we are probably in the best position. The unfortunate (or fortunate for Nintendo) situation is that Nintendo is sitting on a big pile of cash, they have a BoD that until recently has not pushed for further increases in market growth or stock appreciation. I say "until recently" as our former MS BoD member ValueAct has been heavily acquiring shares of Nintendo (<https://www.reuters.com/article/us-nintendo-valueact-exclusive-idUSKCN2232VT>) and I've kept in touch with Mason Morfit as he's been acquiring. It's likely he will be pushing for more from Nintendo stock which could create opportunities for us. Without that catalyst I don't see an angle to a near term mutually agreeable merger of Nintendo and MS and I don't think a hostile action would be a good move so we are playing the long game. But our BoD has seen the full writeup on Nintendo (and Valve) and they are fully supportive on either if opportunity arises as am I.

How many monkeys does it take to make a neural-computer interface?

A new report details the gruesome cost of Neuralink's rapid development and suggests that founder Elon Musk is more willing than most to put animals in harm's way to achieve results.



If you look to the history books of pioneering fields like medicine, psychology and even space exploration, you don't have to go far to find harrowing examples of inhumane actions done in the name of science. We like to think that we've evolved beyond the need for these extreme experiments; opting for lighter touch solutions that take longer, but inflict far less suffering. And when it comes to experiments on human subjects, contemporary safeguards in many countries make it far less likely to be unethically treated during an experiment, but you'd probably struggle to make such a compelling case for experiments on animal subjects.

A recent reminder of this came in September when Elon Musk, serial Tweeter (now X poster) and founder of brain chip startup Neuralink, replied to a user on his social media platform after they linked to an article about the deaths of test monkeys for the company's bionic brain interface. Musk's response was pretty unequivocal, stating that: "No monkey has died as a result of a Neuralink implant."

However, just ten days after making that comment in September, a report by *Wired*

revealed a petition to the SEC by a medical ethics group claiming that the majority of Neuralink monkeys were killed as a direct result of the surgical procedures to insert chips into their brains. The report details some compelling evidence found in publicly available veterinary records of the animal research undertaken by Neuralink and describes 12 monkey deaths that are likely to have been directly caused by the company's research.

The *Wired* report highlights an experiment in 2019 where a monkey died after a Neuralink chip that broke during surgery, causing an infection, and another instance where a monkey, labelled Animal 15, "began to press her head against the floor for no apparent reason" following recovery from a surgical implant procedure. Her condition subsequently worsened until she was finally euthanised as a result of further complications.

These scientific documents form the basis of an argument by the Physicians Committee for Responsible Medicine (PCRM) that has been sent to the SEC, requesting that Musk be investigated on securities fraud for false claims about the research underpinning the publicly listed company.

These medical research papers matched the reported experience of a former Neuralink employee and current University of California, Davis primate centre researcher that asked to remain anonymous for the *Wired* interview. This researcher strongly refuted Musk's subsequent X post that, "[Neuralink] chose terminal monkeys (close to death already)" for the experiments, stating that the comment was "ridiculous" or a "straight fabrication" since the test subjects required up to a year of behavioural training, which would have excluded any animal that was "close to death".

Neuralink is about to begin testing on humans with some of the final certifications for medical testing being approved in the last few months. The company announced that recruitment would open in September for quadriplegics that want to volunteer for clinical trials of mind controlled computer software. Given the altruistic goals and potential positive impact of the company, it makes for an interesting societal question: exactly what lengths are we willing to go to continue to rapidly progress cutting edge medical technology. **Joel Burgess**



Joel is one of the senior journalists on *APC* magazine and apart from being the resident laptop, monitor and fitness tech geek, he's also pretty into surfing his local Sydney beach breaks when he's not in front of a screen.

How it works

Nvidia DLSS 3.5 and ray reconstruction.



Jarrod Walton
Jarrod has been described as an AI by people he meets at parties.

DLSS originally stood for 'Deep Learning Super Sampling' but since its introduction in 2018, Nvidia has used it as an umbrella term for any graphics technology that leverages AI. Now, Nvidia has introduced Ray Reconstruction and DLSS 3.5, which will use AI to improve the quality of ray tracing effects. So how does Ray Reconstruction work and who benefits?

The second part is much easier to answer. DLSS 3.5, unlike DLSS 3.0 Frame Generation, will work with any and all Nvidia RTX GPUs. That makes the new features potentially far more interesting than if they were only limited to the latest generation RTX 40-series hardware. Ray Reconstruction only benefits games that use ray tracing effects, so if you're playing a game that only uses rasterization, DLSS 3.5 has nothing to offer. AMD and Intel GPU users also have nothing to gain from DLSS 3.5.

As to how it works, an AI model gets fed tons of data, "learning" to produce high-quality outputs from lower-quality inputs. In this case, Nvidia has trained the model with surface colours, motion vectors, and normal maps along with the reference images showing high-quality ray-traced renders. Ray Reconstruction

works with multiple different ray tracing effects as well, including reflections, global illumination, shadows, and more.

Ray Reconstruction has some similarities to upscaling in that both temporal and spatial components get considered by the training. Temporal means that samples are used across multiple frames, while spatial indicates a form of interpolation or "filling in the blanks" from adjacent pixels. Denoising can provide a higher quality output even with a limited number of pixels, and that's what Ray Reconstruction aims to do.

DLSS 3.5 will launch this Spring, with *Cyberpunk 2077 Phantom Liberty* one of the first games to incorporate the feature. The most demanding ray-tracing games will deliver the biggest improvements and Nvidia used *Cyberpunk 2077* with RT Overdrive mode enabled as a demo. But Ray Reconstruction will be more about improving quality than boosting framerates.

Cyberpunk running at native 4K on an RTX 4090 managed around 20fps in RT Overdrive mode. DLSS 2 upscaling in performance mode (1080p to 4K upscaling) boosted that to 63fps. Adding DLSS 3 Frame Generation increased to 100fps. Finally, turning on DLSS 3.5 Ray Reconstruction resulted in 108fps. That eight percent

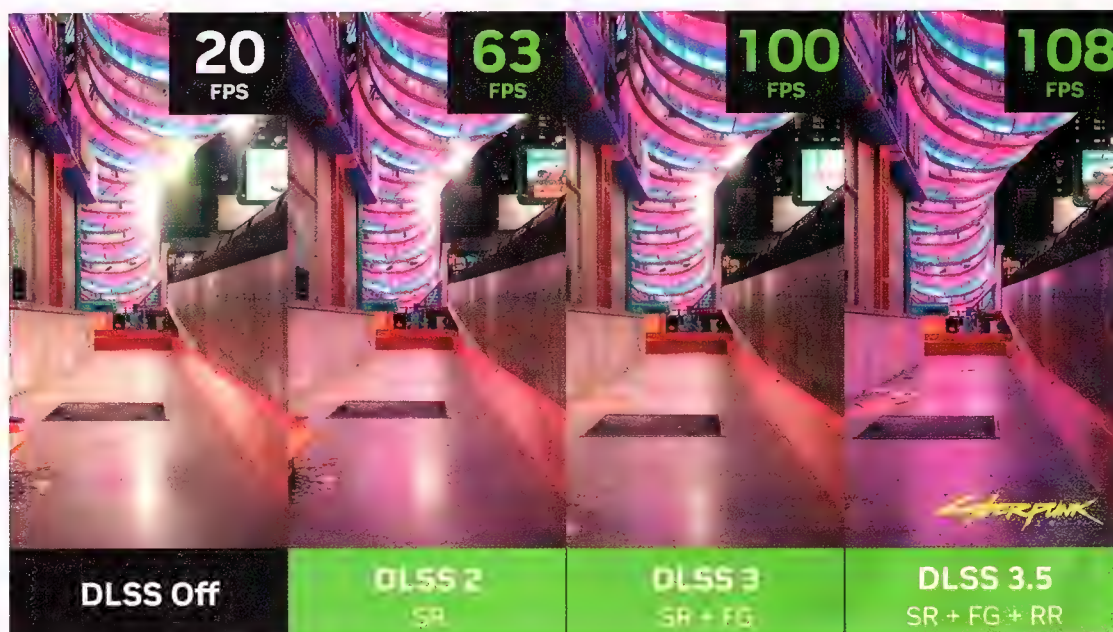
increase from Ray Reconstruction won't be typical, however, as the bump in framerates is down to the replacement of multiple denoiser algorithms with Ray Reconstruction.

Still images don't do the technology justice. The lights above the walkway cycle through different patterns and, while regular *Cyberpunk* shows some changes, with Ray Reconstruction, the whole environment is lit up in different hues. Developers could mimic this via other rendering techniques that are far less demanding, but those wouldn't be as accurate as ray tracing.

Professional path tracing applications are planning to add DLSS 3.5 support, with D5 Render and Chaos Vantage already committed to the technology. It's not clear when support will be available, but Ray Reconstruction should allow even better real-time previews of complex renderings.

The uptake of Ray Reconstruction may be more muted than DLSS 3 Frame Generation, as there aren't many games that will massively benefit. On the other hand, the existence of another tool in the DLSS suite could mean that we'll see more "full ray tracing" games in future. Just don't expect them to run great on non-Nvidia GPUs.

Jarrod Walton ■



Cyberpunk 2077 Phantom Liberty will be one of the first games to incorporate Ray Reconstruction.

Intel's glass substrates are coming to the processors of the future

What's a house without a strong foundation?

Computer chip technology marches ever on. We're used to seeing chips with more cores, more cache, and more transistors at smaller nodes, but what we don't often focus on is a chip's packaging and substrate. Current organic substrates are nearing their limits. Intel knows this and has been researching new substrate materials to enable the next generation of chip design. The answer is glass.

In this issue, you can read about my experiences at Intel's Malaysian facilities, where I witnessed first hand how Intel goes about assembling its chips. I saw Meteor Lake chips being made. But while Meteor Lake and its tile-based architecture is impressive, it pales in comparison to Intel's compute GPU, codenamed Ponte Vecchio. It has a die area of 1,280mm² and packs in no less than 47 tiles made with five different process nodes and 100 billion transistors. It's pushing the limits of organic woven substrates. With glass substrates, Intel will be able to continue scaling tile and core counts for many years to come.

A glass substrate doesn't mean you'll be seeing transparent glass chips with dies on top. It means the core of the substrate will be made with glass. Things like metal wiring and layers will still be present, but

shifting to a glass core brings many benefits.

According to Intel, glass substrates are able to tolerate higher temperatures. This has benefits for multi-tile packages – think enterprise and datacenter applications, where thermal stresses can disrupt interconnects, especially as a chip's tiles can operate at very different temperatures. It also allows Intel to integrate optical interconnects. More bandwidth between tiles can only ever help a processor's overall performance.

The next benefit is interconnect density. With higher density optical interconnects, the chips of the future will be able to accommodate more tiles. Ponte Vecchio's 100 billion transistor count looks pretty tame, as Intel believes it can produce processors with one trillion transistors by 2030. As AI explodes, Intel believes it will be well placed to meet the insatiable demand for computing power for many years to come.

What does this mean for consumers? Honestly, not really a lot in the short to mid-term. Chips and packages with dozens of tiles, integrated HBM memory, vertical chip stacking and stunningly high bandwidth, low latency

interconnects will first go into lucrative enterprise processors, as they do now. Consumer desktop and laptop chips aren't running into the same walls. Not yet, anyway.

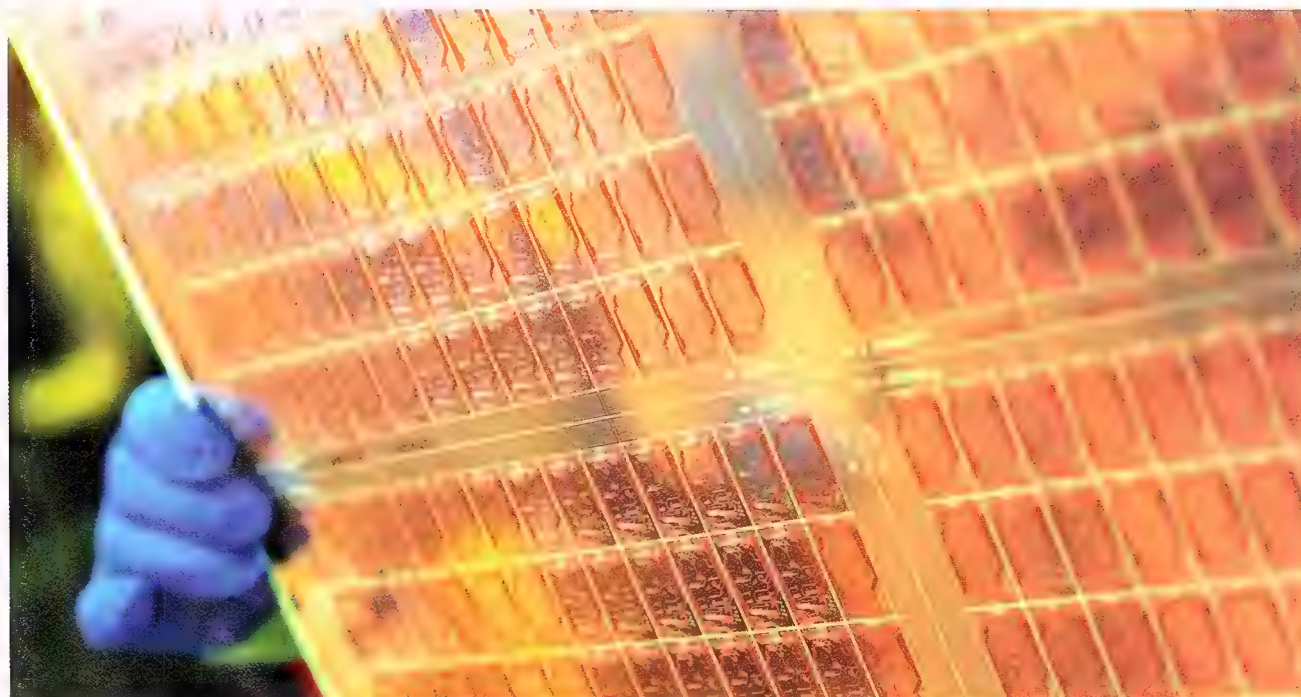
In the future, as we enter the Angstrom era and sub-2nm nodes become widely available, we'll see consumer chips with glass substrates. Disaggregated or modular chips are the future, and that means we need faster interconnects and more new substrate technology. Meteor Lake is just the start. We could see tiles with individual cores, cache, AI specific tiles, or an iGPU with more or fewer cores. The building blocks will get smaller, and the physical, electrical and optical properties of glass substrates will allow Intel – and surely the likes of TSMC too, to keep transistor counts scaling, keeping Moore's Law front and center.

Glass substrates could apply to GPUs too. AMD's RDNA 3 GPUs are a step on the path to disaggregated GPUs. Need more cache? Compute clusters? Heck, how about ray tracing cores or ROPs? You could theoretically just bolt them on. It's not as easy as that, but with glass substrates, we're certain to see some very exciting chips before the decade is out.

Chris Szewczyk ■



Chris has been elbow deep in PCs since before the turn of the millennium, and he wouldn't have it any other way.



TRADE CHAT

Is AMD retreating from the high-end?

Red has cancelled some GPUs, but don't panic!



AMD probably won't be replacing the 7900 XTX. But that definitely doesn't matter.



Jeremy Laird
Has a black leather jacket just like Jensen's.

"It wasn't until July that a sole 7900 board, the XTX, appeared in Steam's Hardware Survey"

Spend enough time in this game and you get a feel for rumours that are very likely true. And I'm getting the sense that the latest ones suggesting AMD has ditched the high-end variants of its next-gen RDNA 4 graphics family are on the money. At first glance, this seems pretty disastrous, especially given how expensive gaming GPUs have become and

how desperately we need somebody to put Nvidia under pressure. But is it? Is it actually?

The bones of the story go like this. AMD has cancelled not only the top Navi 41 GPU but also Navi 42. It's the mooted cancellation of Navi 42 that's most worrying. Navi 41, just like Navi 31 and Navi 21 before it, was slated to be the big boy of the RDNA 4 series. It's the most exciting GPU of the family, but also the least relevant.

That's because few gamers can afford high-end GPUs. Navi 31 in the form of the Radeon RX

7900 XT and XTX were released at the end of last year. But it wasn't until July that a sole 7900 board, the XTX, appeared in Steam's Hardware Survey, clocking up a mere 0.17 percent of gamers. If you combine the 7900 XTX with all variants of the previous-gen high-end, the 6800 and 6900 Series based on Navi 21, they don't even add up to 1 percent.

So, Navi 41 is no great loss. Hardly anybody would buy it anyway. AMD's mid-range cards like the 6700 XT and 6750 XT hardly dominate the survey. But they do rack up a few percentage points and they help to keep Nvidia honest with the likes of the RTX 3060 and 3070 series. At least they would if AMD had direct competitors.

Anyway, the point is that Navi 32 and, in turn, Navi 42 are more mainstream GPUs. And the loss of not only Navi 41 but also Navi 42 implies that AMD might not even be able to field what would presumably be known as the 8700 XT. It would only be competing at the very low end, leaving Nvidia without any competition for anything above what will presumably be then -

and we're talking early 2025 for any of these GPUs to actually go on sale - be known as the RTX 5060.

Well, unless Intel can get its act together with Arc. That's not impossible, but you'd hardly bet on it. So, that's the potential horror story for PC gamers. No mid-range or high-end AMD GPUs for the next generation, allowing Nvidia to price its cards even more offensively. Except that may not actually be what's happening.

So we're left with Navi 43 and Navi 44. My hunch is that Navi 43 has probably been adjusted in response to the cancellation of Navi 41 and 42. It was likely always going to be a monolithic design, rather than chiplet based. But AMD will adjust the scale and scope of Navi 43, pushing it up into the mid-range.

That's probably why all this news leaked in the last month or so. It's just far enough out from the launch of RDNA 4-based Radeon RX 8000 Series GPUs to allow AMD to revise Navi 43 and Navi 44 to account for the loss, primarily, of Navi 42. But there's no reason to panic.

Jeremy Laird ■

ONE MORE THING

Ancient tech treasures

The future is fantastic, but so is the present day argues Jon Honeyball.



I love a good computer jumble fair. You never know what you might find, and there is always the tantalising possibility of coming across something extremely rare that you have been hankering after for years. Even decades. So when I heard that the most excellent Centre For Computing History in Cambridge was going to be holding just such an event, it had to go into the diary.

Upon arrival, straight away on a table I spotted something that immediately piqued my interest. A fully boxed HP 360LX Palmtop PC, complete with accessories, manuals and full documentation including the licence sheet from Microsoft for CE 2.0. Which even had the hologram sticker in place. I had one of these back when they were new, so how could I not renew the acquaintance?

I asked how much it was. "How much is it worth to you?" came the reply, which was not exactly unreasonable. I pondered, and he suggested "how about ten bucks?" Dear reader, I couldn't say no.

Starting up this almost 25-year-old folding keyboard and screen was a real leap into history. I was soon presented with

the Windows CE Handheld PC set up screen. After the routine and nostalgia-triggering setup process, finally I landed on the desktop, and what a delightful blast from the past this was. The Start menu at the bottom left, as God and Bill Gates intended. An icon on the desktop for "The Internet" – it was so good of HP to include all of it on the device – along with Pocket Word, Excel, PowerPoint and the usual Contacts, Calendar, Inbox. Oh, and the BSquare Fax Professional app too, just in case.

On the one hand, despite its age, this remains an entirely usable device. The keyboard action was good, the pen adequate. Even the display was crisp and fairly clear, with a backlight that still worked. Albeit in a somewhat dim and distant "candle at the end of the hallway" level.

That first ten minutes of play was a tidal wave of nostalgia, of remembering how things were in a simpler era. Of how my dear departed mother was quite shocked back then that you could do so much on a device so small that it could fit in your coat pocket.

Then reality set in. The performance was really hopeless. The screen's low contrast made me squint after a few minutes, which happened to coincide with the battery life of the two supplied AA batteries. The plastic case and general build quality was a creaking horror compared to the incredible engineering done by Apple and Samsung today.

I am still positively thrilled to have played with this again, and reminded myself that we really have made progress. I could have saved myself the tenner by using one of the dozens of devices at the Museum, all lovingly set up and ready to go. But there is nothing quite like sitting on your own sofa, trying to get a feeble shadow of Excel working on a handheld device, where the display is best described as being its own shadow.

The late great Gerry Anderson, of *Thunderbirds* fame, apparently once said, "the future was fantastic". I shall return to the HP 360LX every few months, and be grateful that it is, indeed, fantastic compared to even the turn of the century.

Jon Honeyball ■



Jon Honeyball
Jon still winces
at WinCE.

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The A-List

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ALTERNATIVES

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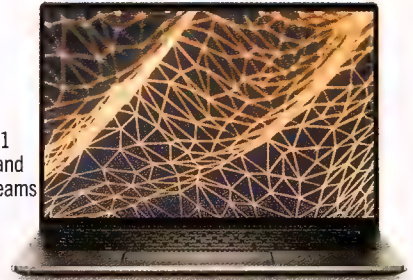
APC rates the Intel model highly, the SQ3 model less so. With Intel, you get a solid upgrade to the world's leading detachable tablet laptop. \$1,649, microsoft.com

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ALTERNATIVES

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RAZER BLADE 15 (2022)

A SUPERBLY ENGINEERED GAMING POWERHOUSE

Right now there's just not another better value gaming unit around. It's miraculously thin considering the beefy components inside, thermals are very well managed and the Razer Blade 15 manages to extract very good performance from its GPU without undue throttling. There are many variants and options, and they're an outstanding buy if you find one on sale. ~\$3,199, razer.com/au-en



ALTERNATIVES

LENOVO LEGION 5I PRO (16IN)

A great-value gaming laptop that extracts the most from its powerful components. We really love the keyboard, too. From \$2,399, lenovo.com/au

RAZER BLADE 18

A great advert for 18in gaming laptops, the Blade 18 partners a Core i9-13950HX with RTX 40-series graphics in a stunning, slim design. \$4,499, razer.com/au-en

ASUS ROG STRIX SCAR 18

It's expensive, but if you want an 18in laptop that delivers all-out power this is the no-compromise 3.1kg beast to buy – it packs quality everywhere. \$4,999, asus.com/au

EVERYDAY LAPTOPS

ASUS ZENBOOK S 13 OLED (UX530)

ASUS AND INTEL TEAMED UP TO BUILD A MACBOOK AIR KILLER

A compact and budget friendly Ultrabook that's the best available device for many on-the-go professionals. Compared to the MacBook Air 13, it has an additional HDMI and USB-A port, an SSD that's roughly twice as fast, and the screen is brighter and offers rich OLED contrast. \$1,945, au.store.asus.com



ALTERNATIVES

MICROSOFT SURFACE LAPTOP GO 2

Runs cool and quiet, and has up to 30 percent better battery life than its predecessor, all in a beautifully designed form. From \$1,099, microsoft.com

APPLE MACBOOK AIR 15

An awesome plus-size MacBook Air with great battery life and graphical performance. GPU performance and battery life are the standout perks here. From \$2,199, apple.com/au

HP PAVILION 14

This slim 1.4kg laptop is a superb choice for anyone on a tighter budget. It struck an excellent balance between speed and battery life – around ten hours. From \$999, store.hp.com

CHROMEBOOKS

ASUS CHROMEBOOK FLIP CX5

The best big-screen Chromebook we've tried, with a bright 15.6in Full HD display with decent black levels and surprisingly rich colours. And it's a good specification for the price, with a Core i5 processor, 8GB of RAM and a 256GB SSD in tow. **\$797, [asus.com/au](https://www.asus.com/au)**



LENOVO FLEX 3 CHROMEBOOK

This isn't the most powerful Chromebook, but students need reliability more than power – especially if they're only really using it for homework, note-taking, and perhaps the occasional bit of Netflix. **\$484, [lenovo.com/au](https://www.lenovo.com/au)**

LENOVO IDEAPAD DUET

The Chromebook answer to Microsoft's Surface tablets, this is a seriously versatile device – albeit not the speediest (although we never found it to be painfully slow while carrying out everyday tasks). For this price, and with a 16hrs 14mins battery life, the Duet is a great choice. **\$599, [lenovo.com/au](https://www.lenovo.com/au)**

TABLETS

APPLE IPAD PRO 12.9IN

M2 POWER IN YOUR PALM
Blurring the boundaries between laptop and tablet like never before, the M2-powered iPad Pro 12.9-inch is every bit as fast as we expected – and the Liquid Retina XDR display is simply phenomenal. **From \$1,399, [apple.com/au](https://www.apple.com/au)**



GOOGLE PIXEL TABLET

A powerful and vibrant tablet that works seamlessly as a Google Home Hub. Google's first local tablet is an awesome addition to your smart home, and its lower price point doesn't hold it back from competing with the best. **From \$899, store.google.com/au**

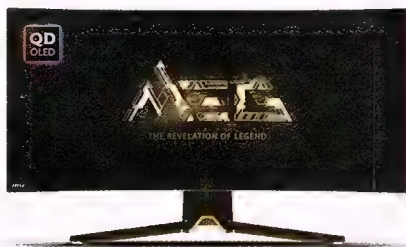
NEW ENTRY SAMSUNG GALAXY TAB S9 ULTRA

This 14.5in tablet offers a size and versatility that even the iPad Pro can't match, with its high price more than justified by the quality of Samsung's AMOLED panel, speakers and productivity software. **\$1,999, [samsung.com](https://www.samsung.com)**

EVERYDAY MONITORS

MSI MEG 342C QD-OLED

THE BEST PANEL OF 2022 AT A MORE AFFORDABLE PRICE
Quantum Dot technology combines with an OLED self-emitting panel to offer brighter, more efficient and more colourful visuals than your average OLED screen. **\$1,799, [msi.com](https://www.msi.com)**



EIZO FLEXSCAN EV2480

Businesses in particular will love this easy-to-roll-out 24-inch monitor, with its exceptional five-year warranty, USB-C port for easy docking, excellent viewing angles and delicious whites. And it has the best OSD around. **\$699, [eizoglobal.com](https://www.eizoglobal.com)**

DELL S2721DS

The Dell S2721DS is a solid and affordable QHD monitor that'll suit general users and casual gamers alike. It boasts a gorgeous 27-inch 1440p display, a 75Hz refresh rate, and a vivid IPS panel that hits 99 percent of the sRGB color gamut. **\$341, [dell.com/au](https://www.dell.com/au)**

PROFESSIONAL MONITORS

EIZO COLOREDGE CG319X

CREATIVE MASTERCLASS
As the price indicates, this monitor is for heavyweight creatives who demand the best in every discipline: HDR video editing, print layouts, professional photography and more besides. With superb coverage and accuracy across all spaces, plus a built-in calibrator, it justifies the investment. **\$5,995, [eizoglobal.com](https://www.eizoglobal.com)**



BENQ PD2725U

By no means a cheap 4K 27-inch monitor – unless you compare it to the Eizos – but it marries all-round quality with ease of use thanks to a puck that allows you to quickly move between settings. You can even daisy chain a second Thunderbolt 3 monitor for a monster setup. **\$1,599, [benq.com](https://www.benq.com)**

ASUS PROART PA279CRV

Asus's new 4K productivity panel delivers near pro-levels of performance and precision, though its HDR capability is inevitably limited. What you get is Asus's usual high levels of build quality, plus extras, including essential HDR support and a stand that includes rotation into portrait mode. **\$849, [asus.com](https://www.asus.com)**

HOME OFFICE PRINTERS

EPSON ECOTANK ET-1810

BACK TO BASICS
There's nothing flashy about this bottle-fed inkjet: it's there to churn out pages at a decent rate (8.8ppm for black text) for a low price. It comes with enough ink for 4,500 black pages and 7,500 in colour, but refills are cheap. Just don't expect features like duplex printing. **\$265, [epson.com/au](https://www.epson.com/au)**



CANON PIXMA PRO-200

Yes, it's big and it's expensive – and you don't even get a scanner – but the Pixma Pro-200 means that you can print A3 photos with glorious colour accuracy and detail. If you're after an office workhorse, look elsewhere, but it can't be beaten on photo quality. **\$809, [canon.com](https://www.canon.com)**

BROTHER MFC-J4540DW

Home workers will love this inkjet all-in-one. It combines an incredible range of features with all the connectivity you need and extreme ease of use. Output quality is fine, it offers the best cloud support around and the high-capacity ink pack could keep you going for years. **\$329, [brother.com](https://www.brother.com)**

WIRELESS ROUTERS

SYNOLOGY WRX560**THE PERFECT ROUTER**

Its quad-band Wi-Fi smashed-through our performance tests managing 791.5Mbps up close, 375Mbps two rooms away and an amazing 216.7Mbps down the garden.

\$359, synology.com/au

**ASUS ROG RAPTURE GT-AX16000**

The most splendid, overpowered router on the market. But, it's silly money and aspirational to most users. Ultimately, though, it's currently the highest-spec consumer router available.

\$999, asus.com/au

ASUS TUF GAMING TUF-AX4200

Ultimately, this is one of the very best featured and fastest routers we've ever tested and, at \$320, it's a steal. It's affordable, fast and dripping with features. Only power users might want more performance headroom.

\$269, asus.com/au

MESH WI-FI

■ NEW ENTRY

TP-LINK DECO XE200**CLEVER WI-FI 6E**

There are cheaper Wi-Fi 6E meshes, but the XE200 wins for its superb download speeds, excellent coverage and the fact that older clients reap benefits of 6E, not just new ones. And a two-pack should be enough for most premises.

\$1,299 (2-pack), tp-link.com

**TP-LINK DECO X20**

The Deco X20 makes it possible to upgrade your home network to Wi-Fi 6 for the price of some standalone routers.

The HomeCare functions are also a great bonus for households where lots of devices are fighting over the bandwidth. \$199 (2-pack), tp-link.com

ASUS ZENWIFI AX

The interface and design certainly aren't the prettiest (the charcoal version is straight out of the 1980s), but if you're after strong performance, great features and plenty of expansion potential, the ZenWiFi AX is a compelling prospect.

\$406 (2-pack), asus.com/au

NAS SERVERS

QNAP TS-130**SIMPLE HOME NAS**

An above average CPU and RAM combo, solid features and affordable price make the QNAP TS-130 worth considering. Alternatively there's the two bay TS230 which features the same CPU, with 2GB of RAM, dual drive bays, and an extra USB port on the front for a modest ~\$50 price increase.

\$199, qnap.com

**ASUSTOR NIMBUSTOR AS5304T**

This is a hugely powerful four-bay NAS that will be overkill for most people – not just due to its speed but also its slightly intimidating user interface – but techies and gamers should investigate the Nimbustor AS5304T for both its speed and flexibility.

\$799, asustor.com

SYNOLOGY DISKSTATION DS1522+

At \$1,199 it's not cheap but factoring in the software means it's great value. Though some internal silicon may lack headroom, this is still a well-featured, expandable NAS with fantastic software. The best part is the DSM software.

\$1,199, synology.com

SECURITY SOFTWARE

G DATA TOTAL SECURITY

A suite for power users with a host of useful features that offers formidable protection against viruses.

US\$49.95, 1 device, gdatasoftware.com



ALTERNATIVES

AVAST ONE ESSENTIAL

The only product in our tests to score a 100% protection rating for blocking all malicious files, this reliable choice is our pick of the free AV tools and includes a free if limited VPN service. Free, avast.com

MCAFFEE+ ADVANCED

A high-end choice with high-end features and support for an unlimited number of devices. Good value for the first year, but watch out for renewals.

\$139.95, individual, unlimited devices, mcafee.com/en-au

VPNs

NORDVPN

NordVPN provides consistent and fast speeds, serious security, great support for video-streaming services and some cost-effective subscription rates. \$59 per year, nordvpn.com



ALTERNATIVES

PROTONVPN

ProtonVPN provided one of the best free offerings of all the VPNs in our group test, including unlimited data, but upgrade to benefit from even faster speeds and many more options. Free, protonvpn.com

SURFSHARK

A strong rival to NordVPN, especially if you're willing to commit to its two-year contract. It's fast, cheap and a fine choice for people who like to switch to US streaming services. \$79.61 for one year, surfshark.com

PASSWORD MANAGERS

BITWARDEN

Bitwarden has a huge advantage: it's free. It isn't as slick as some paid-for rivals, but it can sync passwords across all devices for no extra charge. Free, bitwarden.com



ALTERNATIVES

DASHLANE

A manager that's ideal for beginners, and it even builds in an unlimited (if basic) VPN service. Note you may prefer to buy the Family plan (\$60 per year) as this extends the service to six people. \$55.99 per year (Premium), dashlane.com

1PASSWORD

1Password is targeted at technically minded users who are looking for the last word in security. It even offers a Travel Mode that may ease your mind if surrendering your phone to customs officials. \$54.99 per year (individual), 1password.com

THE LIST

The best gaming chairs

When it comes to the best gaming chairs, it's all about build quality, comfort, and customisation. You'll be spending an awful lot of time sitting on one, so go for something that will last. We've tested numerous gaming chairs from reputable companies, and these are the pews that proved their worth. So while cheaper office chairs may seem tempting, investing in ergonomics is a decision your body will thank you for in the long run. Treat yourself to something special and give your posterior the care it deserves.

1

SECRETLAB TITAN EVO

\$799,

www.secretlab.com.au

The benchmark by which we judge gaming chairs. It's comfy, supportive, and looks great. Available in three sizes, it's an amalgamation of Secretlab's previous gaming chair models, the Titan and Omega. But this feels better in every regard.

It is pricier than its predecessors, but the upgrades it delivers are genuinely worth it.



2

CORSAIR TC100 RELAXED

\$379, www.corsair.com

The thick cushion, broad design, and refined styling – achieved without compromising on comfort – make this a great gaming chair. Both the leatherette and fabric versions come in at the same price. The one drawback are the 2D armrests – you only benefit from up, down, in, and out adjustability. Compared to chairs with 4D armrests, it's a bit disappointing.



3

SECRETLAB NEUECHAIR

\$979, www.secretlab.com.au

It's arguably more of a "task" chair than a gaming chair, but it's one of the most comfortable chairs you'll ever sit in, and if you're going to be at your desk most of the day working, as well as into the night gaming, then it's worthy investment. It's also backed by a hefty 12-year warranty, which goes some way to offsetting the high price.



4

HERMAN MILLER EMBODY

\$2,925, www.hermanmiller.com

The Herman Miller Embody oozes the premium vibes you'd expect at this premium price. With superb comfort and a warranty spanning over a decade, it's absolutely the chair of choice if you're willing to invest in ergonomics. The tried and tested Embody design is simply one of the best chairs for office work or gaming. It's incredibly comfortable over prolonged use, supports an active and healthy posture, and is easily fitted to your frame. It even comes fully assembled, so there's no fussing with screws or throwaway tools.



5

NOBLECHAIRS HERO

\$599, www.noblechairs.com

If you need lumbar support, Noblechairs has your back. Fully adjustable, it's easy to justify the price tag. Easy to assemble, it's firm and supportive, and very sturdy. The chair is height adjustable, and the backrest has a rake mechanism so you can adjust the angle with its handbrake contraption, and an independent lock tilt mechanism so you can rock freely, or lock yourself almost horizontally. ■

HEAD TO HEAD

Scribus vs Affinity Publisher

Enter the world of publishing with these apps

■ Scribus Free ■ Affinity Publisher \$119 (single app), \$274 (universal license)

First, let's address the elephant in the room. There is one app that has come to dominate the world of desktop publishing, and that is Adobe InDesign. If you're working for a company that uses InDesign, there's no point having anything else. The same goes for QuarkXPress, the former leading light in the industry that has been somewhat eclipsed by the rise of Adobe's app.

It's the same argument that has been put forward for Photoshop or Premiere Pro. If the entire workflow for your project – which involves lots of other people collaborating – is built on Adobe software, then you need Adobe software. Substituting for something else will probably cause the whole thing to collapse.

However, if you're not running or working for a graphic design company, but want something you can keep on your home PC and use to design flyers, posters, greetings cards, or even entire fanzines for hobbies like... err... what do people do when they're not building or using PCs? We're not sure, but there must be something.

Anyway, Adobe takes a lot of fire for its subscription model, which sees you pay each month for a license to use its

software rather than just once. If you stop paying the subscription fee, your software stops working, which annoys a lot of people. The benefits of the model are the stream of updates and beta versions Adobe pumps out, and that a small monthly fee can be more affordable than several hundred dollars at once, and means you can rent it for the amount of time it takes to complete a project, then stop paying. However, we've got something that's potentially even better.

One of the applications we're looking at this month is completely free. It's open-source, and available on Linux and FreeBSD (you can even get an OS/2 Warp 4 version), as well as Windows and Macs. The other is available for a single payment, which isn't even all that much compared to a new graphics card.

Scribus

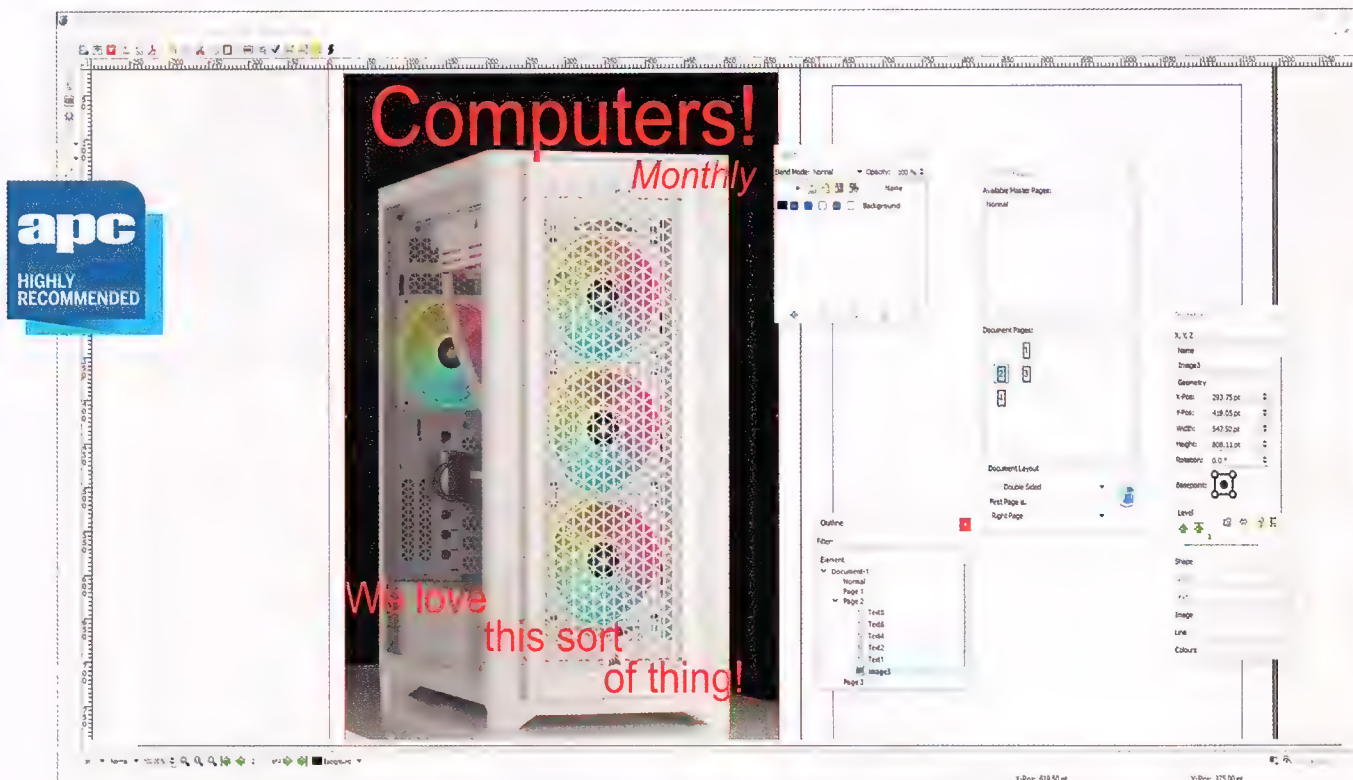
This is the open-source free app. You can download it from scribus.net (although at the time of writing the website was throwing an error that we hope is fixed by the time you read this), or from SourceForge, and the most recent stable version is 1.4.8, released in 2019. The latest preview

release, 1.5.8, came in January 2022, and version 1.6 is expected to be the next stable release, but with only two core developers, progress can be slow.

You'll need to install the GhostScript PostScript interpreter if you want to work with PDF files or PostScript printers, which is available under the AGPL free software license, and will prompt you when you install Scribus. Otherwise, the Windows installer gives you everything you need, without having to fiddle about with extra files.

Once installed, you're able to create a new document as a single page, or one with as many as four folds in it, set up facing pages if you're making a mag, then margins and bleeds to satisfy your printer. There's full CMYK and spot colour support in Scribus too, including custom profiles.

Once you've got a document open, Scribus can make you pause as you work out where everything is, especially if you're used to Adobe applications. Having the toolbar at the top of the screen is probably the first thing that will get changed, slotting it into place at the side instead, then learning that the Properties window is



Scribus' interface is basic-looking, but being free somewhat makes up for this.



Affinity can be purchased for a one-off fee, as opposed to a subscription model.

where you need to go to change things like text size or image fitting rather than having it on display at the top of the interface like InDesign does.

However, once you've used it for a while, it all starts to make sense, and while there are some features that are simply not there, you can usually find what you want by searching the comprehensive forums and wiki, where you'll find a lot of knowledge and a helpful community trying to spread it.

Scribus can work with GIMP, the open-source image-editing program, to do round-trip editing if you need to tweak an image, and it's possible to import PSD files with any spot colours intact.

Affinity Publisher 2

Affinity is an entire suite of creative apps available from Serif Software. The three programs – Designer, Photo, and Publisher – fulfill the roles of Illustrator, Photoshop, and InDesign, but without the monthly fee. You pay once up front for them, around \$119 each (or a \$274 universal license with everything), and they get updates until Serif decides to

release a whole new version, which has happened once already when version two of the software arrived in 2022, eight years after version one. There are Mac, Windows, and iPad versions of all the apps, but Linux users are overlooked.

Publisher 2 acts not only as a standalone page layout app, but as a hub for the other two. As long as you've got them installed, you'll be able to edit a photo in a Publisher 2 layout using the Photo 2 tools instead of having to open that app, then find the file, edit it, and update it in Publisher. The same goes for vector

images in Designer. This is called Studio Link, and is Serif's big idea in the Affinity suite. You can use all the apps on their own, of course, but being able to open a specific toolset inside Publisher saves time and aggravation.

Elsewhere, Publisher 2 is set up to be an InDesign rival. There's full colour separation support, the ability to import PSD and IDML files in addition to PDFs, and the usual array of raster and vector image formats. Its interface owes a debt to Adobe (and Quark), with tools down the left-hand

side and palettes like Layers and the color picker on the right. You'll feel right at home if you've used a DTP app before, though it can take a moment to work out where a particular tool is if you're not already aware.

Serif is extremely good at software support, and there are tutorial guides and videos, as well as an online manual that's completely searchable. The app's New Document dialog got a thorough refresh in the move to version two, and now shows a real-time preview of what your pages will look like once you've finished fiddling with bleed settings. It also has a Recent tab that will save you literally seconds each time if you create a lot of documents from scratch.

Affinity definitely feels better than Scribus to use, though it requires more system resources. But it's hard to argue with getting Scribus for free, especially if it's the sort of app you don't use very often. ■

Scribus Free with Pro features and good image support. Clunky interface though, and with slow development.

★★★★☆

Affinity Publisher No subscription. Very professional feeling, Studio Link. But a steep learning curve and not as common as InDesign in pro settings.
Ian Evenden

★★★★☆

TECHNOTES

Gadgets

Delightful devices.



1

DENON PERL PRO

\$549 | denon.com

Denon is known for bigger bits of audio kit, such as home cinema receivers and multi-room audio. But the PerL Pro is its first foray into the world of true wireless earbuds. Fortunately, these scaled-down audio offerings carry the company's familiar stamp of quality. The PerL Pro offer active noise cancellation (ANC), Bluetooth 5.3, aptX lossless and spatial audio, and you can perfect a personalised sound profile using Masimo Adaptive Acoustic Technology. The earbuds run for eight hours (plus 32 via the case), with IPX4 water resistance.

2

INSTA360 GO 3

From \$599 | store.insta360.com

Insta360 is touting the Go 3 as the 'world's smallest action cam'. The device has a thumb-sized camera which 'pops out' of the device's Action Pod battery charging body. The tiny cam weighs just 35g yet is capable of capturing crisp 2.7K video. As well as its charging capabilities, the Action Pod doubles up as a remote control and live preview flip touchscreen. The camera element is waterproof to 16ft (5m) while the Action Pod body is IPX4 splashproof. The cam features FlowState stabilisation, and the dedicated Insta360 app allows for AI editing of your footage.





3 HYPERX CLOUD III WIRELESS

\$279 | row.hyperx.com

Following the amazing Cloud III we checked out last issue, the Cloud III Wireless offers gamers the same near-perfect headset without the tether. Connecting via the USB C or USB A dongle, the Cloud III Wireless checks all the boxes; rock solid 2.4GHz connection, up to 120 hours battery life, booming sound from the massive 53mm drivers, detachable mic, DTS Headphone:X Spatial Audio on the PC, great passive isolation and cloud-like comfort on the head. For the console gamers, the headset is also compatible with PS4, PS5 and Nintendo Switch.

4 GOPRO HERO 12 BLACK

\$649 | gopro.com/en/au

Action cam pioneer GoPro, has dropped the annual update to its Hero Black range with a camera that offers up to twice as long run-times, Bluetooth headphone or microphone connectivity and a standard tripod mounting screw for the first time. The Hero 12 Black is largely the same as its predecessor with an identical chassis, battery and 27MP 1/1.9" CMOS image sensor — that can shoot video up to 5.3K. The update does, however, add the option for HDR video at full resolution and you now have the option for shooting in RAW colour for enhanced editing capabilities.



5 SATECHI T4 MULTIMEDIA PRO DOCK

\$544 | satechi.net

Satechi describes its Thunderbolt 4 Multimedia Pro Dock as a powerhouse, and with 16 ports and 96W power delivery on offer, it's easy to see why. Made from high-quality aluminium with silicone rubber sides, the dock boasts two DisplayPort 1.4 ports, two HDMI 2.1 ports, seven USB ports, SD and microSD card readers, an in/out audio jack, and 2.5Gbps Ethernet. That 96W of power will sort a computer for a day and you can charge phones and tablets over two of the USB ports. You can add up to four screens at 4K 60Hz (depending on your computer's capabilities) and the SD and microSD card slots can be used simultaneously. Increase your creativity while keeping down the clutter.

HARDWARE

Apple Mac Studio (M2 Ultra)

The new Mac Studio promises serious power and connectivity upgrades, but is the update as impressive as the original breakthrough device?

■ From \$3,299 | apple.com/au



The original Mac Studio, with the first iteration of Apple processors, was an impressive device that really showed the potential of Arm chips in a permanently powered system by beating almost everything else available – so the 2023 update has high expectations to live up to.

Headlining the upgrade list on this device are the new M2 processors which boast improved performance, larger memory capacities, improved bandwidth, and upgrades to the Neural Engine that translates non-native MacOS programs into RISC language and takes on the workload of AI processing tasks.

Much like its predecessor the 2023 Mac Studio is a desktop PC sitting

■ Apple M2 Ultra 24-core CPU; 76-core GPU; 128GB Unified Memory; 4TB SSD; Wi-Fi 6E; Bluetooth 5.3; 19.7 x 19.7 x 9.5 cm; 3.6kg.

above the Mac Mini, without pushing into the specialised \$10K-plus space that the Mac Pro occupies. You can choose from the more approachably priced M2 Max variant starting at \$3,299 or the higher performing M2 Ultra configuration which can be purchased from \$6,599.

The entry unit here uses a similar M2 Max chip as the one found on the top spec MacBook Pro (for a much higher price). They're not identical since the entry Mac Studio SoC has a GPU with fewer cores, but you can upgrade it to match for an extra few hundred dollars.

This entry level Mac Studio is paired

with 32GB of RAM and a 512GB SSD for a pretty powerful configuration considering the overall price. You can easily opt for up to 64GB of RAM and up to 8TB of storage (if you feel like doubling the cost of the unit), but the \$300 1TB storage upgrade and \$600 memory upgrade aren't excessively expensive for those that need a little more than the base configuration.

Ultra performance

For anyone wanting to really push their device into workstation territory there's the option for the M2 Ultra SoC, which uses the same UltraFusion technology seen in the original Mac Studio (M1 Ultra) to sandwich two M2 Max processors together without a significant loss of performance from each chip. This model starts with 64GB of Unified Memory and a 1TB SSD, but can contain up to 192GB of total memory and an 8TB SSD. Pricing here is really about what you need to get your work done, but it's not unreasonable considering it's straddling the enthusiast gaming and custom workstation PC space.

The Mac Studio we were sent to test came with an M2 Ultra with 24 CPU cores and 76 GPU cores, 128GB of

	Apple Mac Studio (M2 Ultra)	Apple Mac Studio (M1 Ultra)
Geekbench 5 - Multi-core (score)	28,833	23,903
Cinebench R23 - multi-threaded CPU	28,550	24,210
Thermal Design Power (TDP)	90W	60W
Geekbench 5 - Open CL (score)	123,512	87,345
Total War Saga: Troy - 1080p Ultra (fps Av.)	89.9	63.1
Sid Meier's: Civilization VI (score)	64	46
CrystalDiskMark Read (MB/s)	7,020	6,225
CrystalDiskMark Write (MB/s)	5,779	5,480



Apple offering is going to consume two or even three times less power than a PC that performs similarly well.

Other updates

The Mac Studio has a higher bandwidth HDMI for 8K or 240Hz displays and can connect up to six Pro Display XDR screens. It's also got updated Wi-Fi 6E and Bluetooth 5.3 compatibility for faster connectivity compared to previous generations. The SSD has been updated to the latest generation PCIe connections, so you'll get 7,000 and 5,759 MB/s read and write speeds respectively.

The footprint sits at just under 20cm squared with a height of 9.5cm, which is an impressively compact 3.8 litre volume for something this powerful. To put that in perspective the Intel NUC 13 Extreme Raptor Canyon, the most compact off-the-shelf PC available, is 3.5 times larger than the Mac Studio overall. And even with this compact size, the lower power draw means heat is more manageable, so the fans are quieter than you'd expect too.

There's nothing we can fault in the connectivity options since if you're working with Mac you're probably going to want to connect everything with Thunderbolt/USB-C ports anyway. If not, you've got an Ethernet, SD Card reader, HDMI and two USB Type-A sockets to interface with non-Apple devices. The device also comes with a built-in speaker for when you don't have speakers connected.

An excellent device for creative professionals that need more power than a Mac Mini can handle.

Joel Burgess

★★★★★

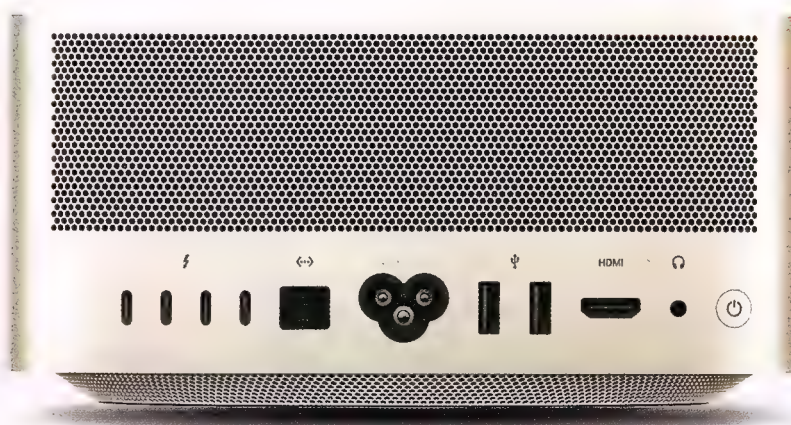
Unified Memory, and a 4TB SSD, a configuration that retails for \$10,799. This is, unsurprisingly, a seriously powerful device capable of outpacing an Intel Core i9-13900K CPU by up to 25% on Geekbench 5, but it also underperforms against the same chip by up to 20% on other benchmarks like Cinebench R23. The CPU performance here is more in line with offerings from Intel and AMD offerings in the enthusiast gaming space, so it's not quite the standout performance we saw from the M1 Ultra when it launched.

You can even get somewhat comparable sizes of compact desktop PCs this time around. If you grab something like an Intel NUC 13 Extreme Raptor Canyon, for example, and fit it out with discrete graphics and plenty of RAM you'll be able to make a PC with comparable performance for roughly the same price as an entry Mac Studio.

When it comes to graphics the M2 Ultra perhaps isn't as big of a leap forward from its predecessors. The Mac Studio we tested doubled the core count against a MacBook Pro 16 (M2 Max 38-core GPU) that we had on file, but this translated to a graphical performance bump of just 58% on synthetic benchmarks and had the same framerates in some gaming applications, which isn't all that impressive. There was a performance jump from last year's 64-core Apple Mac Studio (M1 Ultra), offering 40% better scores on synthetic benchmarks and up to 80% better gaming performance according to our testing, however, and there are a number of creative workflows that offer meaningful GPU performance increases.

When comparing graphical performance to a PC, the 76-core GPU on the test Mac Studio is roughly equivalent to a Nvidia GeForce RTX 4070 (notebook), at least in terms of synthetic benchmark performance. If you do use it for gaming you should expect performance to be significantly lower since we were only able to get around 64-90 frames per second on titles like *Sid Meier's: Civilization VI* and *Total War Saga: Troy* using Ultra 1080p settings, respectively. This means current, graphically intensive games are unlikely to be particularly well optimised.

Fortunately Apple's Unified Memory architecture allows RAM to be accessed directly by the GPU, which will be a massive bonus for some creative workflows. The Apple Mac Studio using the most powerful M2 Ultra also has a Thermal Design Power (TDP) of 90W, 35W lower than the base power consumption of the desktop Intel Core i9-13900K. Once you add the power consumption of a discrete GPU, the



LAPTOP

Gigabyte G5

Gigabyte's 2023 budget-conscious gaming laptop offers 40 series Nvidia GPUs for less.

■ From \$1,199 | gigabyte.com/au

Gigabyte, the company behind Aorus Gaming laptops, has updated its 15-inch G5 entry level gaming laptop to make it a solid contender for the best budget gaming laptop in 2023. There have been a few iterations of the G5 already, some of which are still on shelves today, so the current iteration has been able to keep costs down by dropping either a Nvidia GeForce RTX 4050 or 4060 into the latest offering without tweaking too much else on the existing design.

This strategy means that the entry level RTX 4050 G5 can be had for as little as \$1,199 when on sale, making it cheaper than many devices offering last gen 3050 or even 2050 GPUs. There are a few other sacrifices required to achieve this price point, however. There's only 8GB of included RAM, for instance, and the screen is much duller and less vibrant than any laptop outside the ultra-budget space, but they're concessions that you can live with when the device is on a discount.

The full RRP of the 4050 G5 is \$1,899, a price that isn't as competitive for a unit running an Intel Core i5-12500H CPU, 8GB of RAM and a 512GB SSD, especially when you consider the 8GB RAM allocation will limit the device's gaming performance, and you can get something like the Gigabyte Aorus SE4, with better specs all-round, for the same price.

Gigabyte sent us the RTX 4060 model to test out which is available, currently on sale for \$1,449 (RRP \$2,199). In this category so much is down to the raw cost of the unit, but



■ 15.6-inch 144Hz LCD display at 1920 x 1080 pixel resolution, 250nit Typical Brightness, 60% sRGB, 85-degree viewing angle; Intel Core i5-12500H CPU; Nvidia GeForce RTX 4060 GPU (75W); 8GB RAM; 512GB SSD; 54Wh Battery (4h57min 1080p movie playback); 36 x 23.8 x 2.3cm; 2.08kg.

while the Gigabyte G5 unit saves around \$100 by only offering 8GB of RAM, you take a hefty 10% hit in gaming performance on some modern titles, which just isn't worth the saving. Thankfully, you can buy 16GB of aftermarket laptop RAM for well under \$100 and upgrade the device yourself, which is a great value solution if you don't mind a bit of DIY.

The device we tested managed to

achieve 60-plus fps on RDR2 using Ultra 1080p settings using the stock 8GB configuration, a respectable level of performance for an entry level gaming laptop. The G5's 4060 has a Thermal Design Power (TDP) of just 75W, which means you'll get 4-5 hours of battery life from a small 54Wh battery, but it definitely leaves some performance on the table, lining up with results we have on file for an Acer Nitro 5 using a 140W RTX 3060 GPU.

The performance is well suited to the 15.6-inch 144Hz Full HD screen. You've got enough power to push that to its limits, but only using less demanding or older games. It is a little dull and colours are flatter than you might expect, but you'll get used to it if you don't have anything to compare it to. The only other downside is Gigabyte does not offer compatibility with its Control Center software that would help you optimise gaming performance.

A balanced entry-level gaming laptop that's hard to beat when on sale.

Joel Burgess

★★★★☆

"The performance is well suited to the 15.6-inch 144Hz Full HD screen. You've got enough power to push that to its limits, but only using less demanding or older games."

	Gigabyte G5	Acer Nitro 5
PCMark 10 - Overall (score)	4,821	6,836
Max CPU Temperature (C)	84	97
1080p movie playback (HH:MM)	04:57	03:02
Cinebench R23 - CPU (Score)	11,492	11,557
3DMark Time Spy (score)	8,323	8,351
RDR2 - 1080p Ultra (fps Avg)	63	63.3
CrystalDiskMark Read (MB/s)	4,724	6,922
CrystalDiskMark Write (MB/s)	2,257	4,501

LAPTOP

Dell XPS 13 Plus (9320)

The new XPS Plus is cheaper and more powerful than ever, but does it last long enough to be the best premium ultra-portable laptop around?

■ \$2,196.70 | dell.com/en-au

The XPS range has long been a leading professional ultra-portable, but the Plus range that debuted last year attempted to push that even further by adding a series of high end features to the base level XPS. While that made the XPS 13 Plus a pricey option last year (starting at \$2,599), it's come down a couple of hundred dollars for an entry level model this year.

The 2023 XPS 13 Plus range starts with a device running a 13.4-inch FHD+ display, Intel Core i5 CPU, 16GB of RAM and a 512GB SSD for \$2,398. This wasn't the best value option at the time of writing since there was a higher specced i7-configuration for just \$2,196.70. This i7-1360P model shares all the same entry specifications, but offered a unique discount that didn't extend to the entry variation.

While it's not essential by any means, 1920 by 1200 pixels is a little on the low side for the resolution of a premium 13-inch Ultrabook. Fortunately the upgrade to an impressive 3.5K OLED panel is only \$200. This adds touchscreen capabilities, a much larger contrast ratio and far richer colours than what is on offer with the entry LED screen.

For those that need to work in 4K, you can get the XPS 13 Plus with a 4K LED panel for another \$100 more than the OLED display. While the 4K LED display is fractionally brighter with a 500 nit peak brightness, the OLED panel is able to turn pixels off, giving a much bigger overall contrast range and better colour depth.

The XPS 13 Plus has a nice metal chassis with neat air vents and a glass



■ W11 Home, 13.4-inch LED display at 1920 x 1200 pixel resolution; 500 nit peak brightness; Intel Core i7-1360P CPU; Intel Iris Xe Graphics; 16GB RAM; 512GB PCIe SSD; 55Wh battery (4h 38 mins 1080p movie playback lifespan); 29.5 x 19.9 x 1.5cm; 1.26kg.

keyboard surround that'll insulate your palms from any heat. It also still has the backlit touch bar, fingerprint reader, IR camera with 720p resolution webcam, fast PCIe SSD storage and a nice speaker and microphone array for media and online meetings.

There is enough power on offer from the Intel Core i7-1360P CPU thanks to the 4 performance cores at 2.4-5GHz.

This equates to improvements of 7 - 43% on different CPU benchmarks over an equivalent XPS 13 Plus from last year. This puts it ahead of a M2 MacBook Air by between 13 and 37% depending on the work task.

This performance bump does affect battery life however, since the device we tested was only able to last 4h and 38 minutes in 1080p movie playback which is less than ideal for a device you're hoping to use on the go. You do get a longer 7-ish hour lifespan for light work tasks, which should be enough for most but it's not a full-day and it's a long way from the 19h runtime of the Apple MacBook Air.

The Intel Iris Xe Graphics is roughly equivalent to last year... which means Apple's M2 offers over 20% better graphical performance, but this will still be enough for office workers and the Iris Xe GPU can still play less demanding games if needed.

A powerful professional ultrabook that could do with a bigger battery.

Joel Burgess

★★★★★

"There is enough power on offer from the Intel Core i7-1360P CPU thanks to the 4 performance cores at 2.4-5GHz"

	Dell XPS 13 Plus (2023)	Dell XPS 13 Plus
PCMark 10 - Overall (score)	5,507	5,125
Geekbench 5 - Multi-core (score)	10,133	8,594
Cinebench R23 - CPU (multi-threaded)	11,672	8,161
3DMark - Time Spy (score)	1,880	1,853
Battery life - 1080p video playback (h:min)	4h 38min	6h 6min
Peak CPU temperature (°C)	100	100
CrystalDiskMark Read (MB/s)	7,095	7,082
CrystalDiskMark Write (MB/s)	5,011	5,095

LAPTOP

Dell G16 7630

Does Dell's G16 gaming laptop have the G-force to make it great?

■ \$3,098 | dell.com/en-au

The G16 is your classic performance first gaming laptop. Its 16-inch form factor is bulky and it carries a lot of thermal architecture in its 2.99kg total weight. So while it's able to go into a sturdy backpack, it's not exactly pleasant to commute frequently with.

This additional bulk means it's capable of running a 24-core Intel Core i9-13900HX CPU with a 55W Thermal Design Power (TDP), to really push performance. We tested a Lenovo Legion Pro 5i with very similar specs back in APC 519 and this unit lines up almost identically to that one in performance and specs, sharing the same CPU, Nvidia GeForce 4070 GPU (140W) GPU and 32GB RAM allocation.

You can expect the highest levels of CPU performance available on a laptop in the i9 G16 configuration, with enough overhead to tackle demanding workstation tasks quickly. The GPU isn't in the same league with 4080s and 4090s which can offer up to 47% higher gaming framerates, but you'll pay around twice as much for a laptop with these capabilities. So the 140W 4070 is an excellent value proposition for high performance gaming considering you'll get 100-plus frames per second on current games at 1080p Ultra.

Value is really what is on offer with the G16 since it's \$700 cheaper than the Lenovo Legion Pro 5i. Yes you do take a bit of a hit on the screen which is a 16-inch QHD 165Hz rather than the 240Hz panel you'll get on the Lenovo, but we would argue that that's better suited to the value pitch of the device overall, since the GPU can't really push

far over the 165Hz refresh rate on many titles. G-Sync certification, full sRGB colour and dynamic, integrated MUX switching features are all included and the screen has a 3ms response time so you won't be missing much when it comes to gaming.

The keyboard is nice to type on and there's enough ports thanks to the

Ethernet, HDMI and USB Type-C inclusions. The power brick is a throwback to a few years ago, adding a heap of bulk and close to a kilo of weight, but it'll still go anywhere you need it to.

The Dolby Audio configured speakers deliver great quality sound for media playback and you can expect the latest W-iFi 6E and Bluetooth 5 connectivity specs to keep everything in sync. The device we were sent to review was the top of the line at \$3098.70, but there were offerings with lower powered CPU and GPU combos for as little as \$2,198.90.

The 1TB SSD will be a little small for some gamers, but it offers 4-5GB/s read and write speeds, so it's at least quick to transfer games if you can't permanently fit them. Battery life is pretty disappointing at 3 hours and 48 minutes in 1080p movie playback, but that's to be expected from power hungry gaming laptops.

A well-balanced gaming laptop that offers impressive work and gaming performance for the price.

Joel Burgess

★★★★☆



■ W11 home; 16-inch LED display at 2560 x 1600 pixel resolution, 165Hz, G-Sync, 100% sRGB; Intel Core i9-13900HX CPU; Nvidia GeForce RTX 4070 (140W) GPU; 32GB RAM; 1TB PCIe SSD; 84Wh battery (3h38min 1080p movie playback); 35.7 x 28.9 x 2.6; 2.99kg.

"The Dolby Audio configured speakers deliver great quality sound for media playback and you can expect the latest W-iFi 6E and Bluetooth 5 connectivity specs to keep everything in sync."

	Dell G16 7630	Lenovo Legion Pro 5i 16IRX8
PCMark 10 - Overall (score)	7,000	7,176
Cinebench R23 - CPU (Score)	24,706	25,760
Max CPU Temperature (C)	100	99
1080p movie playback (HH:MM)	3h48min	2h36min
3DMark Time Spy (score)	12,201	11,602
F1 2021 - 1080p Ultra (fps Av.)	149	141
CrystalDiskMark Read (MB/s)	4,978	6,579
CrystalDiskMark Write (MB/s)	4,676	4,928

LAPTOP

MSI Stealth 16 Mercedes-AMG Motorsport A13V

MSI hopes to outpace the competition with this Mercedes branded ultra-portable gaming/studio laptop.

■ \$5,499 | au.msi.com/Laptops

MSI has partnered with car company Mercedes AMG on a customised Stealth 16 Studio A13V laptop dubbed the Stealth 16 Mercedes-AMG Motorsport A13V. The Stealth 16 Studio range is technically pitched at creative professionals since it comes with studio drivers and Windows 11 Pro, but it's a blurry line at best since MSI offers some models with 240Hz monitors that you'd really only use if you were buying a laptop primarily (or at least partially) for gaming.

Mercedes AMG is actually a good partner on this front since the consumer cars offer a premium elegance that line up with the work side of the Stealth 16 pitch, but the company's F1 participation means it's also capable of talking about gaming performance. The Stealth 16 is available in a range of configurations, with various processors, RAM and storage options all starting at \$3,3499 on sale. The Stealth 16 Mercedes AMG A13V sits at the other end of the spectrum as the most expensive Stealth 16 offering with an RRP of \$5,499.

For this you get a 16-inch 4K 60Hz OLED screen, Intel Core i9-13900H CPU and a 105W Nvidia GeForce RTX 4070 GPU, which adds up to a pretty powerful system that's capable of impressive creative performance. The CPU isn't the most powerful we've seen, outpaced by Intel's unlocked 13th gen i9 and i7 processors (which have more performance cores) and AMD's Ryzen 9 7940HS, but it is still very competent and will be capable of handling demanding workloads. The same could



■ W11 Pro; 16-inch OLED display at 3840 by 2400 pixel resolution, VESA DisplayHDR 600; 100% DCI-P3; Intel Core i9-13900H CPU; Nvidia GeForce RTX 4070 (105W) GPU; 32GB RAM; 2TB SSD; 99.9 Wh battery (6h 36min 1080p Battery lifespan); 35.6 x 26 x 2cm; 1.88kg.

be said about the 105W RTX 4070, which is outperformed by systems willing to divert additional power to the graphical capabilities, but which still offers respectable frame rates of around 100 fps on modern titles using 1080p settings.

The device's conservative power draw does help in overall battery life. The

system lasts almost a full work day (7 hours and 8 minutes) in light work tasks. This does drop to 6 hours and 36 minutes when engaging the abundance of pixels on the OLED panel for 1080p movie playback, but the 99.9Wh battery can not be any bigger thanks to flight restrictions. So the only way you'll get a longer lasting laptop is to ditch performance, features or convert to a MacBook Pro.

All this fits into a sleek sub 2cm thick laptop that's covered in a premium metal chassis and which is highly portable at 1.88kg. If portability is your primary concern and power and price are secondary to that then the Stealth 16 Mercedes-AMG Motorsport A13V makes sense, but for an extra 2mm of thickness and 200g of weight you can get an Asus ROG Zephyrus M16 with similar specs for around \$1,200 less. Yes that will include a solid battery life hit, but it's food for thought for anyone who doesn't mind carrying around a power brick.

A powerful and premium ultrabook with a 4K display and an impressive battery life.

Joel Burgess

★★★★★

" You get a 16-inch 4K 60Hz OLED screen, Intel Core i9-13900H CPU and a 105W Nvidia GeForce RTX 4070 GPU, which adds up to a pretty powerful system that's capable of impressive creative performance."

	MSI Stealth 16 Studio A13V	2023 Asus ROG Zephyrus M16
PCMark 10 - Overall (score)	7,083	6,996
Cinebench R23 - CPU (Score)	19,287	19,903
PCMark 10 - Battery Work (HH:MM)	7h8min	4h11min
3DMark Time Spy (score)	11,709	14,341
F1 2021 - 1080p Ultra (fps Av.)	129	161
Cyberpunk 2077 - QHD Ultra RT	29	29
CrystalDiskMark Read (MB/s)	6,473	7,102
CrystalDiskMark Write (MB/s)	4,707	5,279

TABLET

Samsung Galaxy Tab S9

Out of this world.

■ \$1,199 | Samsung.com



This is the smallest and most affordable of the three tablets in the new S9 series. The S9 Ultra has a 14.6in screen and costs \$1,999, the S9+ has a 12.4in screen and costs \$1,699, while the standard S9 we're reviewing here has an 11in screen for \$1,199. That's even less than the last generation Tab S8 is still selling for, and even at its regular price, we have no reservations in calling it our new favourite Android tablet.

As you'd expect from a device at this price, the S9 is a premium product both inside and out. Without a case, the S9 is a slip of a thing at 498g and measuring a compact 254x166x5.9mm. That means you can easily hold it with one hand while scrawling notes or doodling using the supplied S Pen stylus.

Handwriting recognition is by no means perfect, but it's a handy way to scribble down ideas when you're on the move.

The OLED screen has a peak brightness level of 582cd/m², which isn't dazzlingly bright but enough to make it readable in any situation. That's well over 100cd/m² brighter than the Tab S8 and makes it great for watching TV and movies on – an experience made all the more enjoyable

■ Eight-core Qualcomm Snapdragon 8 Gen 2 processor; 8GB or 12GB RAM; 11in 2560x1600-pixel resolution OLED touchscreen; 128GB or 256GB storage; IP68 protection; 13-megapixel rear camera; 12-megapixel front camera; Wi-Fi 6E; Bluetooth 5.3; USB-C port; Android 13 with One UI 5.1; 254x166x5.9mm (HxWxD); 498g; Two-year warranty.

by a superb quartet of speakers that produce surprisingly well-rounded bass tones.

The S9 uses the same components as the S9 Ultra and S9+ – all built around an

"The S9 uses the same components as the S9 Ultra and S9+ – all built around an eight-core Qualcomm Snapdragon 8 Gen 2 chip."

eight-core Qualcomm Snapdragon 8 Gen 2 chip. In our processor benchmark tests the S9 ran around 56 per cent faster than the Gen 1 processor found in the S8. Our test unit had 8GB of RAM (a 12GB model is also available), but this didn't hold it back when we connected it to a 4K screen over USB-C – the tablet continued to

perform smoothly, even with multiple windows open.

This didn't reduce the battery life either, lasting over nine hours in our continuous-browsing test, and just over 13 hours when playing back video. The S9 doesn't come with a charger, just a USB-C cable, so you'll need to provide your own. If you use a 45W fast charger, the battery will go from zero to 24% in 15 minutes.

By 30 minutes it will reach 49%, and will be fully charged within 90 minutes.

The tablet has IP68 protection rating against dust and water, but one sacrifice compared with its more expensive stablemates is the camera. Unsurprisingly, you'll probably find the camera on your current phone is a better option than the S9's, which is limited to a single 13-megapixel sensor. Still, it does capture attractive snaps and can shoot 4K video at 30fps.

If you want the very best 11in Android tablet, there's no question that the S9 is it. If you'd prefer a larger screen, the S9+ or the S9 Ultra are there for you, but prices start to get a little steep.

If you don't want to spend that much and can live with slightly inferior performance levels, the OnePlus Pad is probably your best bet – it's currently available for \$749 from Amazon.

Undoubtedly the best Android tablet you can buy at the moment, replacing its predecessor as our favourite.

APC

★★★★★

ROUTER

TP-Link Deco XE200 AX11000 Tri-band Whole Home Mesh System

A Wi-Fi mega-mesh that uses Wi-Fi 6E and a backhaul channel? Count us interested!

■ \$1,299 | www.tp-link.com/au



TP-Link used to impress us with excellent performance and features at a low price. Then, after winning a bunch of awards, it started pushing mediocre Wi-Fi kit that cost a fortune. However, there's something different about the XE200. It's a two-node, mega-mesh kit that uses the Wi-Fi 6E (6GHz) channel for dedicated backhaul. History suggests that's a winning formula.

The nodes are stylish, large and feature two, 1Gbps network ports plus a rare 10Gbps port. The processor is a speedy 2.2GHz quad-core that ensures all settings and commands are responsive and that there are no internal performance bottlenecks.

We powered on and downloaded the Deco app which immediately found the primary node and simply asked for a network name and password. Done. It even configured all our phone's Wi-Fi settings automatically. Powering on the second node is all it took to add it to the network.

We immediately ran our Wi-Fi tests which see us download large video files to a laptop from a tethered (10Gbps connection) Synology NAS in a single-storey, weatherboard home. We were hoping it could beat the Asus ROG GT6's peak speed of 910Mbps but, up close, the XE200 managed 1,320Mbps! If you don't know what, 'Ground-speed checked' means, Google it.

■ Speed: Tri-band Wi-Fi 6E 11,000Mbps | Connectivity: 2 x Gigabit Ethernet W/LAN, 1 x 10Gbps Ethernet W/LAN | Features: Basic and Premium Parental controls and HomeShield security, Alexa and Google Assistant compatible.

Two rooms away, the speed 'dropped' to 856Mbps which is only just beaten by the GT6's 864Mbps. Nothing else comes close, though. Finally, 15m away, down the end of the garden, the XE200 managed 303Mbps which is the first time our 300Mbps barrier has been broken (the GT6 managed 94Mbps). In short, the XE200 sets new performance and coverage benchmarks that are also the first time we've seen the promised benefits of Wi-Fi 6E manifest.

Unfortunately, features are a mixed bag. The app is well laid out with tabs for Status, Security, Parental Controls and Other options. The problem is the premium 'Security+' features require an annual, \$100 subscription. All you get for free is a new device alert plus basic router security scans. All the intrusion, IoT and Edge protection costs more.

It's almost a similar story with the Parental Controls. Premium options like internet time limits and search protection require an additional \$50 annual subscription. At least the basic functionality is free: you can still assign a device to an individual, manually block its connectivity, perform content filtering, set a weekly access schedule and bedtime.

The additional settings enable the guest network, a dedicated IoT network for smart-home devices, plus standard router fare like port forwarding, address reservation and basic VPN options. It also works with Alexa and Google Assistant for basic, voice-activated controls.

Naturally, innovative speed comes at a premium and \$1,299 ain't cheap – you can buy slightly slower routers, like Asus' TUF Gaming TUF-AX4200, for \$350 which offers TP-Link's subscription features for free.

For enabling next-gen speeds, we heartily recommend the XE200. But, for many buyers, the high-price-tag and not-inconsiderable annual subscriptions (for what are standard features on some rivals) mean they're best off looking elsewhere.

At last, a Wi-Fi 6E kit that delivers on the promise of next-gen performance. But, the high price and subscription-only features hurt the value proposition

Nick Ross

★★★★★

GRAPHICS CARD

Sapphire Nitro+ Radeon RX 7800 XT

A top shelf RX 7800 XT with all the trimmings.

■ \$969 | www.sapphiretech.com

AMD has itself a strong competitor in the Radeon RX 7800 XT. At its base price of \$879, it made the RTX 4070 look pretty pricey, though it became less so after it received a discount. For review we have the Sapphire Nitro+ Radeon RX 7800 XT. It's safe to say it's faster, cooler, and quieter than base models, but it's also more expensive. Is the price of a top-tier RX 7800 XT like the Nitro+ worth its \$90 premium?

The Nitro+ is built around the fully enabled Navi 32 chiplet GPU. It includes a single 5nm Graphics Compute Die and four 6nm Memory Cache Dies. It comes with 16GB of 19.5 Gbps GDDR6 memory and a 256-bit bus. That's the kind of memory configuration we want in a 2023 upper-mid range card. It comes with a 288W TDP, which isn't too bad, but its power efficiency cannot match that of the RTX 4070.

A while back we reviewed the Nitro+ RX 7900 XTX which features a similar chunky, but lovely looking triple slot cooler, though it includes a vapor chamber, whereas the RX 7800 XT doesn't. If it can handle a 420W 7900 XTX, it'll easily tame the 7800 XT Nitro+. In fact, the 7800 XT Nitro+ is one of the quietest cards I've ever come across.

The Nitro+ comes with dual DP 2.1 and dual HDMI 2.1 ports, RGB and fan headers, dedicated VRM cooling, a full cover backplate and a full-length light bar along the side of the card that adds a classy look. Overall it looks and feels like an excellently engineered card.

Performance wise, I expected the Sapphire RX 7800 XT Nitro+ to have a bit more of an advantage over the reference RX 7800 XT, but the end result was only a few frames here and there. I wonder if there is something within the architecture that holds the RX 7800 XT back a little. The chipset vs monolithic



■ 3840 Shader Units; 1624MHz Base Clock, 2565MHz Boost Clock; 16GB GDDR6 19.4Gbps memory, 621GB/s Memory Bandwidth; 2x DisplayPort 2.1, 2x HDMI 2.1a; 2x 8-Pin Power Connectors, 288W TDP.

design could be a contributor.

The RX 7800 XT is a solid competitor from AMD. It competes well with the RTX 4070, though AMD really needs to get FSR 3 out of the gate to counter the advantage (and narrative) offered by DLSS. Its ray tracing is a generation behind, but it's a lot better than it was with the RX 6000-series.

For a limited time, AMD is bundling Starfield with RX 7800 XT cards. There's maybe a strong reason right there to choose an RX 7800 XT over the RTX 4070.

When comparing the Nitro+ to

cheaper RX 7800 XT's, it's hard for me to say which way you should go. It's cooler, quieter, and a little faster. It'll have a higher resale value down the line and it looks amazing. But \$90 is money that could go towards a faster CPU or more memory. Either option has its pros and cons.

The Sapphire RX 7800 XT Nitro+ comes with an awesome cooler, low noise levels and all the trimmings. There's no doubt it's one of the best of all RX 7800 XT's, but you'll have to pay the premium.

The Sapphire Nitro+ RX 7800 XT is a fast, cool and quiet card. If you want one of the very best RX 7800 XT's, here it is.

Chris Szewczyk

★★★★☆

"I expected the Sapphire RX 7800 XT Nitro+ to have a bit more of an advantage over the reference RX 7800 XT, but the end result was only a few frames here and there."

	Total War: Warhammer III			F1 2022			Far Cry 6
	1920x1080 Ultra Preset - Avg	2560x1440 Ultra Preset - Avg	3840x2160 Ultra Preset - Avg	1920x1080 Ultra High Preset - Avg	2560x1440 Ultra High Preset - Avg	3840x2160 Ultra High Preset - Avg	1920x1080 Ultra Preset - Avg
Sapphire RX 7800 XT Nitro+	145	98	60	103	70	34	101
Sapphire RX 7700 XT Pure	126	80	39	93	59	28	118
RTX 4070 FE	134	90	48	109	71	36	115

GRAPHICS CARD

Sapphire Pure Radeon RX 7700 XT

A capable card that's overshadowed by its big brother.

■ \$839 | www.sapphiretech.com

With the launch of the AMD Radeon RX 7700 XT, AMD's RDNA 3 line-up is apparently complete. For review, we have Sapphire's RX 7700 XT Pure. Note that all RX 7700 XT cards are partner cards.

The Pure is Sapphire's mid-tier RX 7700 XT, positioned below the luxurious Nitro+ and above the base tier Pulse. At \$839, the Sapphire Pure carries a price premium over the \$779 price of base cards. That leaves it in a bit of a no man's land. It's a lot more than the RTX 4060 Ti, and less than the RTX 4070. But the main competition for the 7700 XT, and particularly premium models like the Pure, is the 7800 XT, which can be found for as little as \$40 more.

The Sapphire Pure is a gorgeous looking white themed model, and I love it personally. It comes with a small factory overclock and Dual DP 2.1 and dual HDMI 2.1a ports.

The RX 7700 XT is built around the Navi 32 chiplet GPU, the same as that of the RX 7800 XT, with some functionality disabled. Both come with a single 5nm Graphics Compute Die (GCD) and four surrounding 6nm Memory Cache Dies (MCDs) The RX 7700 XT for its part has one of the MCDs disabled.

It's configured with 54 Compute Units, 54 Ray Accelerators, and 96 ROPs. That compares to the 60, 60, and 96 core config of the RX 7800 XT. The RX 7700 XT Pure's rated boost clock is 150 MHz higher than the RX 7800 XT which is a little surprising.

The RX 7700 XT comes with 12GB of 18Gbps GDDR6 memory over a 192-bit bus. The fully enabled RX 7800 XT is equipped with 16GB of 19.5 Gbps memory, a 256-bit bus and more Infinity Cache, which combined give it a major memory bandwidth advantage over the RX 7700 XT. Nvidia's competing cards look downright weak in comparison..

The card's performance is competitive against the RTX 4060 Ti, particularly at rasterization, but Nvidia's RT performance is strong, and it has DLSS 3. AMD's FSR 3 is coming soon. Again though, the RX 7800 XT has a healthy



■ 3456 Shader Units; 1700MHz Base Clock, 2584MHz Boost Clock; 12GB GDDR6 18Gbps memory, 432GB/s Memory Bandwidth; 2x DisplayPort 2.1, 2x HDMI 2.1a; 2x 8-Pin Power Connectors, 240W TDP.

"The Sapphire Pure is a gorgeous looking white themed model, and I love it personally."

performance lead.

The Sapphire Pure has a 240W TBP. The RTX 4060 Ti 8GB comes in at just 160W. But 240W is no challenge at all to the Pure's cooler. It's a card to be seen but not heard. Well done Sapphire.

The Sapphire Pulse RX 7700 XT delivers strong 1440p performance in a quiet package at a power level that's not bad. If only it was around the \$699 mark. As it is, the RX 7800 XT is the better buy, while the RTX 4060 Ti 8GB at around \$650 is a compelling option.

Wait a month or two or six and we'll re-evaluate the RX 7700 XT. It might be overshadowed right now, but in time, the

potential is there for it to be this generation's mid-range gem. Maybe? Maybe not. Time will tell.

We do like the RX 7700 XT, but not its current price. At \$839, it's just not a compelling option compared to the superior \$899 RX 7800 XT, which is arguably the best card in this price range at this point in time.

The RX 7700 XT is a solid card, but while it's priced just below the 7800 XT, it's hard to see gamers warming to it.

Chris Szewczyk

★★★★☆

			Metro: Exodus Enhanced Edition			Temperatures (C)	3DMark
2560x1440 Ultra Preset - Avg	3840x2160 Ultra Preset - Avg	1920x1080 Ultra Preset - Avg	2560x1440 Ultra Preset - Avg	3840x2160 Ultra Preset - Avg	Full system power (w)	Average	Time Spy Extreme GPU
122	73	110	81	46	347	57	9,245
103	60	96	70	38	308	57	7,683
110	65	107	87	50	287	59	8,573

POWER SUPPLY

Asus TUF Gaming 850W Gold PSU

A tough and fair PSU.

■ \$229 | asus.com



Asus's TUF Gaming series are designed with long-term reliability and high performance in focus and are being marketed accordingly. The new 850W Gold variant of this series aligns with Intel's ATX 3.0 design guidelines, with the 80Plus Gold certification and 10-year manufacturer's warranty as the major highlights, and retails for a reasonable price tag.

A fair bundle can be found inside the box of the TUF Gaming 850W Gold PSU. Aside from the typical AC power cable and the mounting screws, Asus also supplies several cable ties, three quality cable straps, and a thick manual in 30 languages. There is also a "certificate of reliability" that indicates which tests the capacitors and chokes of the units had to pass for Asus to use them. Most of them are done in accordance to the MIL-STD-202 and MIL-STD-810H standards, which gave Asus the ground to boast about "military-grade reliability". The tests are performed by iST, an independent laboratory based in Taiwan.

The TUF Gaming 850W Gold is a fully

modular design, allowing for the removal of every DC power cable, including the 24-pin ATX connector. All of the cables are black, with black connectors and individually sleeved wires, including the ATX 24-pin and the new 12VHPWR cables. It is interesting to note that the total number of connectors is fairly low for a unit with that kind of capacity.

"The TUF Gaming 850W Gold is a fully modular design, allowing for the removal of every DC power cable, including the 24-pin ATX connector."

and receive the 80Plus Gold certification with an input voltage of 230V if ASUS pursued it. The average nominal load range (20% to 100% of the unit's capacity) efficiency is 90.9% when powered from a 230 VAC source, which drops to 89.8% with an input voltage of 115 VAC.

Asus went with a semi-passive thermal design with an impressively lax cooling

The overall efficiency of the Asus TUF Gaming 850W Gold PSU is very good, with the unit easily meeting the 80Plus Gold requirements with an input voltage of 115V. Although the unit has its efficiency certification officially only with an input voltage of 115V, it would also pass the higher efficiency requirements

profile that has the unit operating fanless for more than half its entire load range. Once the fan starts, which would take a load of over 550 Watts at room temperature, it is barely audible. The fan speed quickly increases as the load reaches the maximum of the unit's capacity but never becomes too loud. Conversely, the internal temperatures of the unit are allowed to climb significantly before the fan begins to spin, suggesting that Asus' engineers have a lot of faith in the resilience of this unit's components.

In light of its features, performance, and affordability, the Asus TUF Gaming Gold offers excellent value at its current price point of \$229. This competitive pricing, combined with its compliance with the ATX 3.0 standard, positions the unit as an attractive choice for those seeking a high-performance power supply solution. Despite minor caveats, the Asus TUF Gaming Gold stands as a compelling option, addressing the needs of PC enthusiasts and professionals alike, making it a worthy addition to the Asus TUF Gaming lineup.

Well engineered and easily able to deliver the claimed power.
E Fylladitakas

★★★★★

WIRELESS GAMING MOUSE

BenQ Zowie EC3-CW

Can a wireless mouse really cut it for the most demanding of gamers?

■ \$229 | zowie.benq.com

Why is this no-frills looking wireless mouse so expensive? It's all in the (minor) details. The Zowie EC2-C is often cited as being among the greatest tools for FPS pros, especially *Counter-Strike*. The EC3-CW is a wireless version of that respected workhorse. It's for serious players of serious twitch-oriented competitive games. Nowadays, that is not incompatible with wireless peripherals.

The question of value was on my mind as I unboxed the EC3-CW. It's a lean beast, with no tactile grips (or "dimples") on either side of its elegant / kind of boring matte veneer. I didn't like this smoothness at first, but the matte finish didn't lead to the slippage I expected, and it's also easier to clean.

Other surprising minimalist traits: There are conspicuously few areas that could come alight RGB-style. There are zero superfluous trimmings: not even the Zowie logo comes alight, though a subtle line of light beneath the scroll wheel illuminates when docked to its wireless receiver, to indicate its power level. It's a supremely comfortable mouse to use though, weighing in at under 80 grams, and with just enough rise at the palm hump so that it feels as if blending into my claw grip.

Functionality is simultaneously great and boring. It skids smoothly both on desktop and mouse mat with a spare set of skates in the box. Left and right clicks are crisp and definitely on the louder side, and the steps in the scroll wheel are heavily pronounced though still effortless to use. OK: the loudness of the clicks might annoy someone in the next room, but to you they will sound great. I love that sensation of mechanical feedback.

That "enhanced" wireless receiver is arguably more

"The Zowie EC3-CW wants to be the go-to wireless mouse for competitive gaming and there's no reason why it can't be."

interesting than the mouse itself, which boasts a 3370 sensor. The enhanced receiver connects via USB-A to your PC and doubles as a charging unit. A tiny 2.4GHz USB receiver dongle also comes in the box, and you can also use it wired if you want, though that would undermine the whole value proposition here.

With my PC connected to a wireless headset and keyboard, and with all manner of other wireless signals buzzing around my workspace I received no glitchy interferences here. Standing three metres

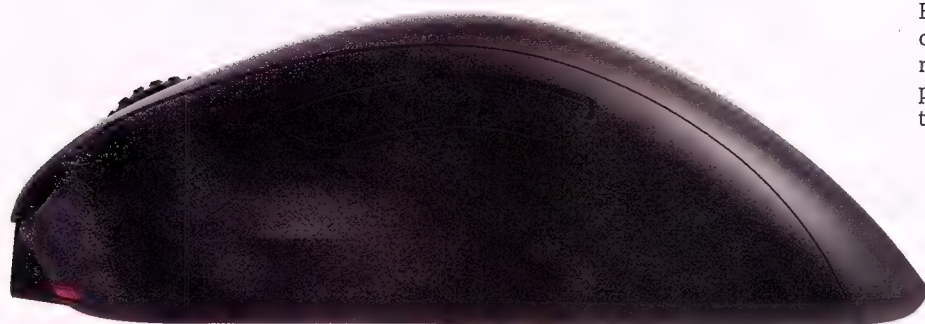
from the receiver itself, I noticed no significant lag or shaping problems using VsyncTester. It's about as faultless as you can expect from a wireless mouse, and when I begrudgingly plugged it in I didn't feel like I was getting a better experience.

The Zowie EC3-CW wants to be the go-to wireless mouse for competitive gaming and there's no reason why it can't be, judged on merit alone. Sure, it doesn't have a 8,000Hz polling rate, and it's not breaking any other records in terms of weight, DPI, etc, but my gaming monitor doesn't have a 500Hz refresh rate either: I can't imagine needing it.

The question is, why would you buy this at \$229? Most obviously, because you love the wired versions of the ECX-C line: many do. The vast majority of PC gamers don't need a wireless mouse with these specs at this price point, but if you do, it's going to be hard to beat.



■ Sensor: 3370; DPI, 30,000DPI; Polling Rate: 1,000Hz; Size: 119mm x 61mm x 41mm; Connectivity: 2.4GHz wireless; Buttons: 5; Battery: 70 hrs; Ergonomic: Right-handed; Weight: 76g.



A wireless version of an eSports legend that ticks all the boxes.

Shaun Prescott

★★★★★

SMARTPHONE

Samsung Galaxy Z Flip5

Samsung's engineers continue to refine the folding phone game.

■ \$1,649 (256/8GB); \$1,849 (512/8GB) | samsung.com



If you're not a fan of the Fold, why not try the Flip? Whichever way round you prefer your hinges, Samsung has you covered, and this fifth-generation clamshell smartphone is its most mature and practical model yet.

One big advantage of the Z Flip5 over the Z Fold5 is the price – it's a whopping \$1,000 cheaper, and now comes with 256GB of storage as standard, up from the Flip4's 128GB. There's also a 512GB option.

The expanded display isn't all that's new about the Galaxy Z Flip5. The other major upgrade is a new hinge, which lets the phone close up completely with no more gap – catching up with rivals such as the Motorola Razr 40 Ultra and the Oppo Find N2 Flip. It's very pleasing to use, with a nice snap-shut closing action. An IPX8 protection rating means that, as before, it's not guaranteed against dust intrusion, but that's par for the course among today's folding phones.

Without a doubt, the star of the show is the new front display. Successive Z Flip phones have seen the

■ 8-core (3.36GHz/2.8GHz/2GHz) Qualcomm Snapdragon 8 Gen 2 SoC; 8GB RAM; Adreno 740 graphics; 6.7in foldable 120Hz AMOLED screen, 1,080 x 2,640 resolution; 3.4in AMOLED cover screen, 720 x 748 resolution; 256GB/512GB storage; dual 12MP rear cameras; 10MP front camera; Wi-Fi 6E; Bluetooth 5.3; 3,700mAh battery; USB-C 3.2 Gen 2 connector; Android 13, One UI 5.1.1; folded, 72 x 15.1 x 85mm (WDH); unfolded, 72 x 6.9 x 165mm (WDH); 187g; 1yr warranty.

notification strip gradually grow in size, but it's now ballooned into a 720 x 748 display which Samsung calls the "Flex Window". It's vastly more functional than the cover displays on previous models, with support for widgets and apps, plus a useful viewfinder mode for capturing photos and videos. Not all apps can be run on the external screen just yet, but several of the biggest names are working at launch – including Google Maps, Messages, Netflix, WhatsApp and YouTube – and I suspect that more will be added as time goes on. It makes a real difference to the user experience: I love being able to glance down, read messages and reply immediately via the on-screen keyboard on the outer display, without having to open up the phone.

The screen looks good too, with

punchy colour tones and wide viewing angles. At the same time, it blends in with the design so neatly that it's hard to tell the display is even there when it's switched off.

Inside, meanwhile, the folding 6.7in AMOLED display retains the same dimensions as the previous generation. That means it still has a tall 22:9 aspect ratio; the shape makes it easy to swipe left to right, but reaching the top corners is a bit of a stretch. It has a sharp native resolution of 2,640 x 1,080, and it looks better than ever, as its brightness has been dramatically improved to a maximum of 1,504cd/m² – almost double the Flip4's peak of 772cd/m².

Perhaps inevitably, Samsung hasn't managed to completely eliminate the dreaded crease that runs along the middle of the screen, but compared to older models it feels slightly less prominent. In fairness, no one's yet managed to get rid of it completely, although if you're really turned off by creases then the tiny indentation along the Motorola Razr

"It has a sharp native resolution of 2,640 x 1,080, and it looks better than ever, as its brightness has been dramatically improved to a maximum of 1,504cd/m² – almost double the Flip4's peak of 772cd/m²."



40 Ultra's inner display is even less conspicuous.

Winning smile

The camera setup on the Galaxy Z Flip5 is mostly unchanged from the Z Flip4 – which sadly means there's still no telephoto lens. Instead, you get a 12-megapixel f/1.8 main camera, plus another 12-megapixel ultrawide f/2.2 camera. The camera app is exactly the same as last year's version, but that's fine as it includes some great extras like portrait video, hyperlapse, and director's view. I particularly love the fact that the Samsung continues to offer manual video controls, something none of the competition can match.

Unsurprisingly, pictures tend to come out looking much the same as they did on last year's phone. However, if you directly compare shots from the two models, you might notice that the Flip5's exposure seems better balanced – the Z Flip4 had a tendency to lean over-exposed, and I also prefer the warmer colour production of the Flip5. The biggest improvement is to shadowy areas and night-time photography: Samsung says that the Z Flip5 uses new AI-powered processing to enhance low-light detail, and the effect is clearly visible, with brighter, more

detailed shots than on the Flip4.

The Z Flip5 is also better for taking selfies than past models – not because the front camera itself has improved, but because the larger screen works better as a viewfinder when you're pointing the camera at yourself, with no annoying cropping as on previous generations. You can also use the 10MP camera of the main display – either way you get, sharp, warm images.

Battery life

Battery life was a weakness of the Galaxy Z Flip4. We'd normally hope to see a high-end smartphone last at least eleven hours in our continuous web-browsing test, but the Flip4 conked out after a little under nine. For comparison, the Galaxy S23 Plus managed 12hrs 28mins, and it's the same price as the Z Flip5.

I was therefore initially disappointed to note that the Flip5 packs the same-sized 3,700mAh battery as before. Happily, the more power-efficient Snapdragon 8 Gen 2 chip helps extend its longevity: I found the Galaxy Z Flip5 lasted almost a full hour longer than its predecessor, for a total of 9 hours and 53 minutes. That's not quite as good as the Motorola Razr 40 Ultra, which

managed 10 hours and 9 minutes, but it means the Z Flip5 is likely to get you through a day's use.

Verdict

There are compromises – in particular, battery life is acceptable rather than great. It's also a little bit of a shame that there's only a limited range of apps that'll work on the front screen, when the Motorola Razr 40 Ultra lets you run anything you like there. Overall though the Galaxy Z Flip5 is surely the best flip-phone we've seen so far; even if it's not the most adventurous upgrade, it's impressive enough to demand a serious look from anyone seeking something more than a standard smartphone.

Longer battery life, a more usable Flex Window and outstanding cameras help this flip phone stand out.

John Velasco

★★★★★

SCREEN LIGHTING

Nanoleaf 4D

Screen-matching smart lights are colourful fun.

■ \$169 (65in); \$229 (85in) | nanoleaf.me



Back in 2004, Philips wowed TV watchers with Ambilight, its first TV equipped with a rear-mounted light strip. The TV claimed to produce a more immersive viewing experience by splashing colours on the wall behind it to echo those on screen. While Ambilight is a lot of fun, it's hardly essential, especially when it means having to buy a whole new television in order to take advantage of it.

However, smart-lighting geniuses Nanoleaf have come up with a better way... Nanoleaf 4D takes the Philips Ambilight idea and runs with it, enabling anyone with a television to achieve a similar effect with minimal outlay.

In the box, you'll find Nanoleaf's first addressable light strip, which comprises a string of LED lights (10 per metre) with an adhesive back, a black Screen Mirror Camera and a matching Nanoleaf 4D controller. Also included in the kit are four corner pieces for the rear of your TV, plus all the cables you need.

Simply put, the Screen Mirror Camera watches the colours displayed on your TV, then sends that information to the

Nanoleaf 4D controller, which translates those into the colours the addressable light strip splashes on the wall behind your TV. The camera can be mounted above or below your TV and points directly at it (like a reverse webcam). The camera doesn't record anything and has only been designed to watch your TV, although there is a magnetic privacy cover included if you feel you need that.

You can tweak what the camera sees on your screen using the Nanoleaf app, where you'll also find calibration and other set-up options for the Nanoleaf 4D itself.

Getting the system up and running is fairly straightforward with the Nanoleaf 4D hooking into Google Home, Alexa, Apple's HomeKit and Razer

Chroma. You can also group it with any other smart-lighting setups that you happen to have at home to create a Scene ("Hey Siri, switch to Cinema mode"). In the Nanoleaf app, you'll find that Nanoleaf 4D has five Screen Mirror modes: 1D, 2D, 3D, 4D and Off. You can also switch the lights to Rhythm mode so they respond to sounds as well as pictures. Plus, there's Sync+, which

enables you to invite other Nanoleaf smart lights to the Screen Mirror party.

You can also choose how bright the LED fireworks behind your TV are by choosing between Cinematic, Vivid and Custom from the Vibrancy settings. And you'll find Basic, Scene and Rhythm options, just like you would get on other Nanoleaf systems.

The Screen Mirror's 1D, 2D, 3D and 4D modes are a bit of a curio: 1D splashes a single-colour (usually white) onto the wall behind your TV; 2D does something similar, but uses the dominant on-screen colour; 3D mixes ambient lighting with some dynamic effects based on what's happening on-screen; and 4D delivers a fully immersive dynamic effect, again based on what's happening on-screen.

And it works brilliantly. Screen Mirror is pleasing and fun and really enhances your viewing experience, and does everything you'd expect an Ambilight TV to do – splashing the wall behind our TV with splashes of red, white and orange during the climatic battle on Crait in *Star Wars: The Last Jedi*, for example, while delivering more subtle effects elsewhere.

A fun and affordable smart-lighting system that could change the way you watch movies and TV.

Rob Mead-Green

★★★★★

DRAWING TABLET

Xencelabs Pen Tablet Medium Bundle

Everything you need from a drawing tablet.

■ \$499 | digital3d.com.au



When it comes to fully featured graphics tablets, Xencelabs is on a tear right now – and it's easy to see why. The company's Pen Display 24 wowed us recently with its incredible build-quality and cool features. Now it's the Xencelabs Pen Tablet Medium Bundle's turn. And it's great.

For \$499 you get a medium-sized graphic tablet (measuring 320.5x232.5x8mm), a Quick Keys remote control, two styli (the 3-Button Pen and the Thin Pen with two buttons) and a pen case, which comes with all kinds of add-ons and accessories. An equivalent Intuos Pro tablet from Wacom would cost \$599 just for the tablet alone – accessories like a second thin pen and spare nibs will cost extra.

The Xencelabs Medium Tablet Bundle's pen case is, ahem, a case in point. Not only does it contain the two aforementioned pens, it also has 10 spare combo nibs, six standard nibs and four felt nibs. Plus a Bluetooth dongle, a nib extracting ring and a USB-C adaptor inside.

■ Pen Tablet Medium (320.5x232.5x8mm, 710.5g) Quick Keys remote, 1x Thin Pen (12g) and 1x 3-Button Pen (17g) both with 8,192 levels of pressure sensitivity, Wi-Fi or USB-A connectivity (USB-C adaptor supplied), up to 16 hours of battery life.

As for the pens, both have an eraser button on top and offer up to 8,192 levels of pressure sensitivity, along with 60 degrees of tilt, making it easy to turn doodles into gorgeous graphics.

Going hand-in-hand with the tablet and pens is the Quick Keys remote. This marks a key point of difference between Xencelabs' and Wacom's tablets, as while Wacom's extra function buttons and controls are built into the tablet, Xencelabs' are largely separate. On the Quick Keys remote you'll find a jog wheel, eight programmable buttons (with up to 40 presets)

"For \$499 you get a medium-sized graphic tablet, a Quick Keys remote control, two styli and a pen case, which comes with all kinds of add-ons and accessories."

and an OLED display for ease of use. The advantage of having these functions on a separate controller becomes obvious when you use it – whether you're left- or right-handed, the controls can be moved to exactly where you need them, minimising the risk of covering up the buttons when drawing.

The Medium Tablet measures 8mm thick and is just a little larger than a sheet of A4 paper. It has a sturdy metal base and rubber feet, plus a palm rest so your wrist always remains comfortable during long drawing sessions. The drawing area is framed by four corner LEDs, which are customisable with eight different colours. There are also small programmable buttons along the top.

Set-up is painless. The driver comes with presets for major apps that support tablet input and we never suffered any lag while using it, or instances of un-registered contact. Pressure sensitivity is easy to judge, and easily repeatable, which makes for a natural drawing experience.

This is a stunning piece of hardware, and proves Xencelabs is a serious contender. The bundle is great value, while the build quality and design are exceptional.

Possibly the best tablet on the market, suitable for enthusiasts and professionals alike.

Paul Blachford

★★★★★

Windows 10 or 11 | tinyurl.com/APC525fix**FIXWIN 11.1***System tool*

You can fix many problems with Windows by tweaking the registry or running special commands, but unless you know what you're doing, you could further mess up your PC. FixWin provides one-click repairs for dozens of common issues and annoyances, in an attractive, easy-to-understand interface, and it works with both Windows 10 and 11.

The program's Welcome screen provides handy shortcuts to run the System File Checker (SFC) and DISM commands, which are often all you need to fix PC errors, as well as the option to create a system restore point before you make any changes. If these don't help, you can explore its range of fixes, which are organised into logical categories, such as File Explorer, Internet & Connectivity and System Fixes.

Rather than baffle you with jargon, FixWin uses plain English to explain problems you may be experiencing, such as 'Recycle Bin icon is missing from Desktop', 'Cannot connect to internet' and 'Start menu doesn't open', as well as error messages like 'Task Manager has been disabled by your administrator'.

Before you click the Fix button to repair a problem, click the question-mark icon to learn exactly what FixWin

will do, such as delete a specific registry key or run a particular command. Fixes are applied instantly, though you may need to restart your PC for them to take effect.

The Troubleshooters section gives you one-click access to the various troubleshooters tucked away in the Windows Settings app, including tools to fix problems affecting your printer, network adapter and PC sound. There

are also quick fixes for resetting different aspects of Windows, such as your Windows Update history.

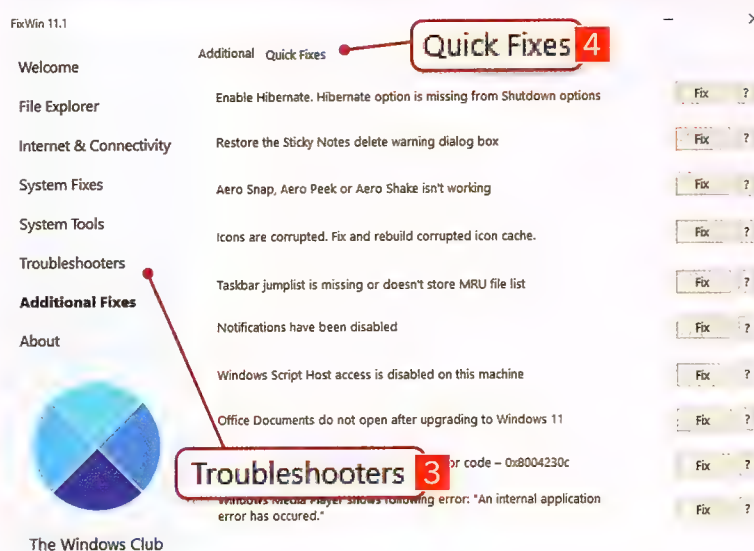
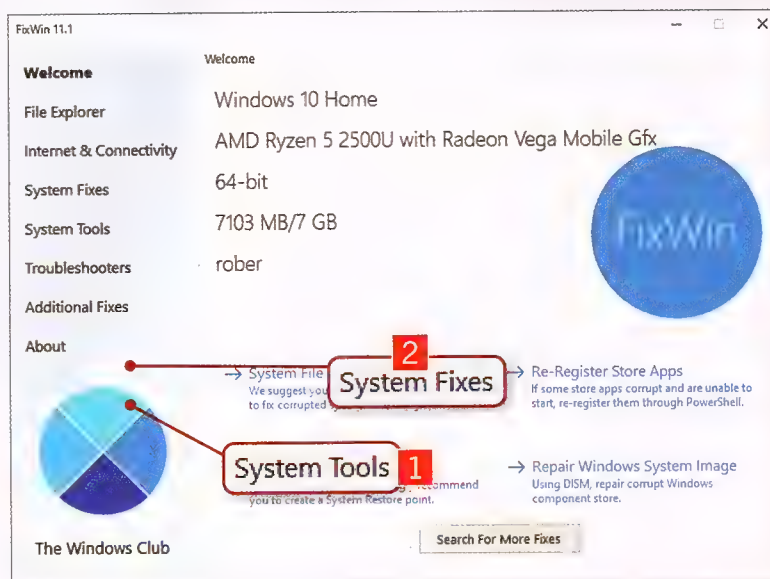
FixWin couldn't be easier to use and this latest version fixes a few bugs in the program itself. Note that, because it makes changes to your PC, FixWin may trigger a Microsoft Defender SmartScreen warning, but it's safe to use so click 'More info' then 'Run anyway'.

1 FixWin automatically detects your Windows version and other system info so it can provide relevant fixes. To view further details, such as your processor speed and available RAM, click System Tools, then Advanced System Information.

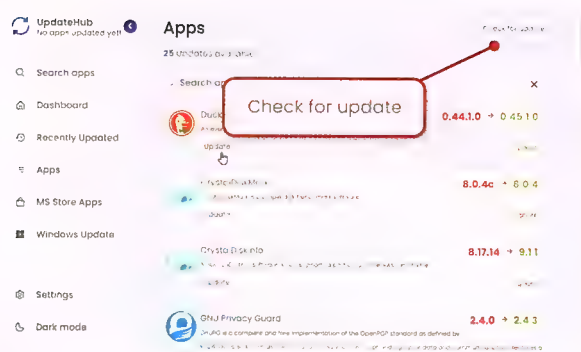
3 The Troubleshooters section gives you one-click access to 18 troubleshooting tools, to identify and fix problems with Windows software and hardware. You can download additional troubleshooters from FixWin's developer, TheWindowsClub.

2 Click 'System Fixes' to browse a wide range of common PC problems, including tools that won't open, updates that fail and specific error messages. Click the question mark next to an entry for an explanation, then click the Fix button.

4 In the Additional Fixes section, you'll find solutions to less common problems, such as corrupted icons and Aero Shake not working. Click the Quick Settings tab to reset different Windows tools including Microsoft Defender and the Settings app.



"FixWin provides one-click repairs for dozens of common issues and annoyances, in an attractive, easy-to-understand interface, and it works with both Windows 10 and 11."

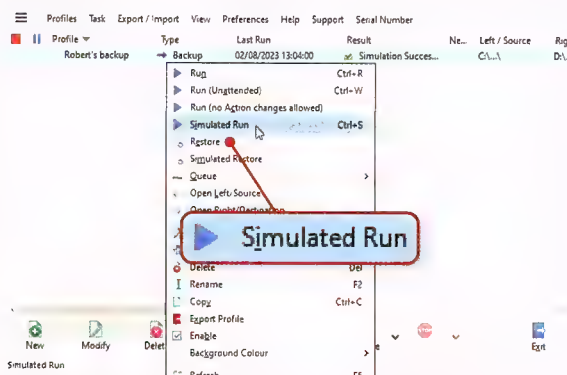


Windows 10 or 11 | www.snipca.com/47101

UPDATEHUB 2.1

Software updater

UpdateHub makes it easier to keep all your software updated, to protect your PC from security threats and performance bugs. Rather than update tools manually or wait for automatic updates, click the 'Check for update' button (see screenshot) to see which installed programs and Microsoft Store apps have updates available. Click a tool's Update button to download and install the latest version. The 'Recently Updated' tab lets you keep track of which software has been updated and roll back to the previous version if you have any problems. UpdateHub itself is updated automatically and this release makes several improvements. These include speeding up the search facility, fixing the Ignore button (which dismisses updates) and showing the download size for update files – go into Settings to enable this option. You can also switch to dark mode with a single click.

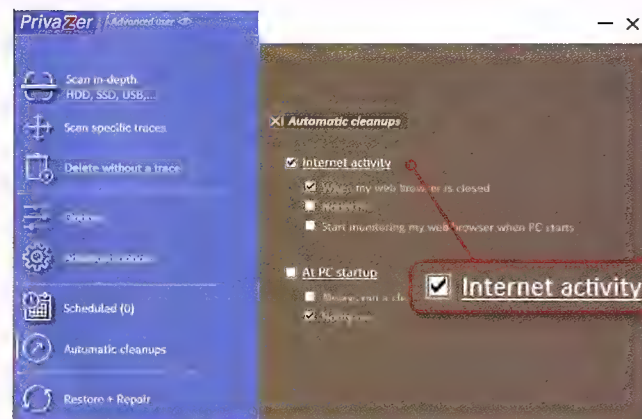


Windows 7, 8.1, 10 or 11 | github.com/KK-Designs/UpdateHub

SYNCKFREE 11

Backup tool

This free backup tool has been updated with a host of new options and improvements that make it easier to back up and restore files. Particularly useful is the ability to test the copying process before you perform it properly, to ensure you've selected the right files and folders. Simply right-click a backup in your profile and choose Simulated Run (see screenshot) – or Simulated Restore to copy in the other direction. In the Differences window that opens, you can filter files by name or extension to find specific items faster, and decide which action to take if two files are detected to be identical, such as deleting the copy or ignoring it. SyncBackFree's backup log now includes a bar chart showing how many files were copied in the previous seven runs, and you can set up a keyboard shortcut to instantly launch the program from the system tray.



Should I pay for...?

Windows 7, 8.1, 10 or 11 | From \$14 | Free trial: N/A | privazer.com/en/index.php

PRIVAZER PRO

Web tool

PrivaZer is the one of the best free tools for safely deleting traces of your PC and web activities. But it also has a paid-for Pro version – alternatively known as the Donors edition – which offers several extra features.

Unusually, PrivaZer Pro lets you decide how much you want to pay for it – the default amount is \$49, but you can go as low as \$14. This buys you a licence key that you enter in the standard program to unlock its full range of tools.

The main advantage to upgrading is automatic cleanup of your data, to ensure nothing that could compromise your privacy is ever left behind. Select 'Automatic cleanups' in PrivaZer's left-hand menu and tick the 'Internet activity' box (see screenshot). You can decide whether to wipe data automatically when you close your browser or be notified first. Tick 'At PC startup' and 'Always run a cleanup' to begin each Windows session with a clean slate. It's not difficult to scan for and delete this data manually, but these options provide a safety net in case you forget.

The other Pro-only options are less enticing. A year's worth of automatic updates is hardly an incentive when you can easily update PrivaZer yourself – indeed, it usually informs you when a new version is available. Priority support will only come in useful if something goes seriously wrong with the program, and the ability to run PrivaZer from the command line is a feature only tech boffins will appreciate.

"The other Pro-only options are less enticing. A year's worth of automatic updates is hardly an incentive when you can easily update PrivaZer yourself – indeed, it usually informs you when a new version is available."

OUR VERDICT: Don't pay for it

The free version of PrivaZer has all the tools you need to erase your private data, so the only real reason to upgrade to Pro is to support the program's development. Automatic cleanup is handy but it's not essential, and probably not worth \$14.

LOGIC PRO FOR IPAD

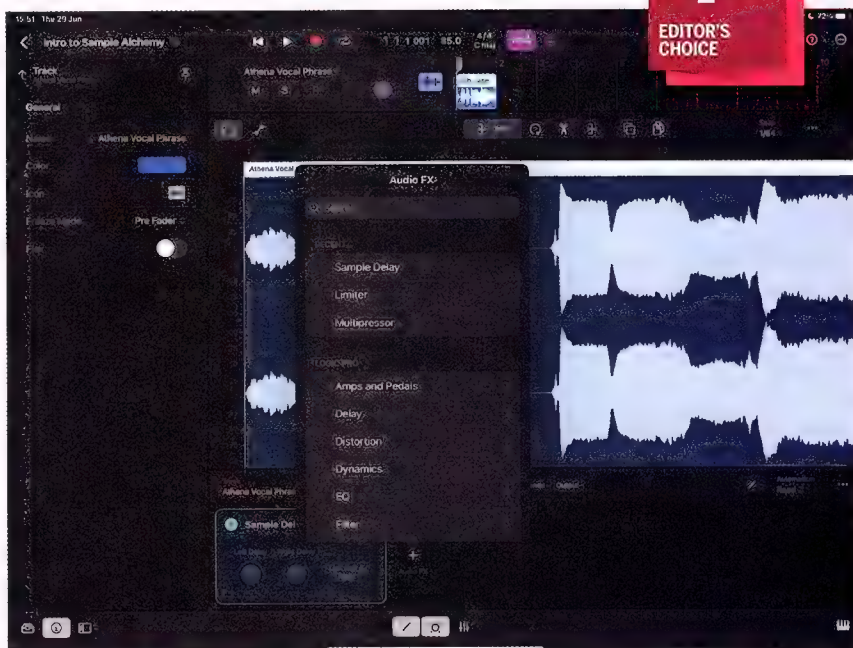
Pro-level music tools come to iPad.

■ Needs iPadOS 16.4 or later (device with A12 Bionic chip or later) | \$7.99/month, \$59/year (one-month free trial) | apple.com/au

Apple has been trying to convince us for a number of years that an iPad can replace a Mac for professional creative work and, in a handful of cases, like art and graphics that's arguably been true. For music production, however, serious Digital Audio Workstations (DAWs) haven't made the leap to iPad, with the notable exception of Steinberg's Cubasis. Perhaps in an effort to remedy this, Apple has created Logic Pro for iPad. Light years more powerful than GarageBand, it's also not a direct port of Logic Pro for Mac. Instead, Apple has created a supremely powerful new app that will be familiar to existing users but is completely reworked for the touch interface.

Unlike Final Cut Pro for iPad with its exacting graphics requirements, Logic Pro works on any iPad with an A12 Bionic processor or better, which includes all recent models. This, combined with its one-month free trial, means a great many people will be able to try it out for themselves. While the app is around 700MB, a full install of all its loops and content weighs more like 15GB which, when combined with space for recordings, could be an issue for iPads with lower capacities. We tested on an M1-powered iPad along with an A12 version and, while performance on the M1 iPad was buttery smooth, it was slower but still acceptable on the older model.

This is a remarkably accomplished music production suite and one that perhaps only Apple with its vast resources could have pulled off. As such it's possibly a little daunting for newcomers, but a number of excellent



A good selection of instruments and effects is included.

tutorials and walkthroughs are provided to get you up and running. There are several track types available – MIDI and pattern-based software instruments, audio and drummer tracks.

The content library lets you preview patches, loops and samples and drag and drop these into your project. For each track type, advanced, desktop-class editing tools are available and these extend to beat-stretching audio, generating MIDI patterns and much more.

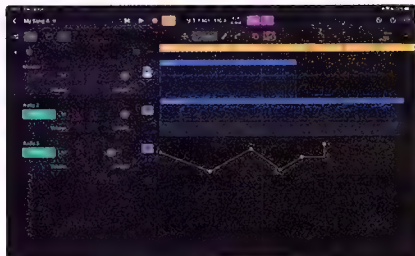
Extensive Apple Pencil support makes tasks like drawing automation curves a breeze.

Customisable interface

Many of Logic's classic software instruments and effects plug-ins have been carried over and are available to load into projects. Audio Unit plug-ins for iOS are supported but these are not nearly as commonplace as they are on the desktop. So while you can transfer projects between iPad and Mac via iCloud or the share sheet, any Mac plug-ins will need to be bounced down to audio before they can go over to the iPad. Hopefully the release of this app will encourage developers to up their game when it comes to iOS audio plug-ins.

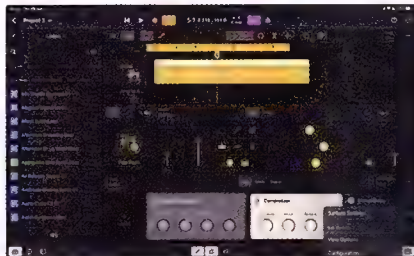
Logic's design is superb, doing away with windows in favour of a highly

GETTING THE BEST OUT OF LOGIC PRO



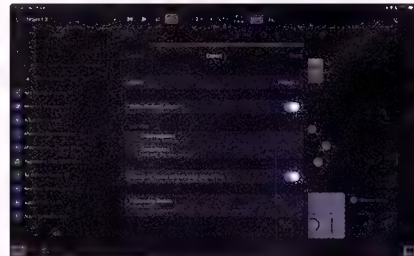
AUTOMATE VOLUME AND PAN

Logic lets you use your finger or an Apple Pencil to enter automation curves to change volume, panning, filters and many other parameters over time for a more interesting and dynamic mix.



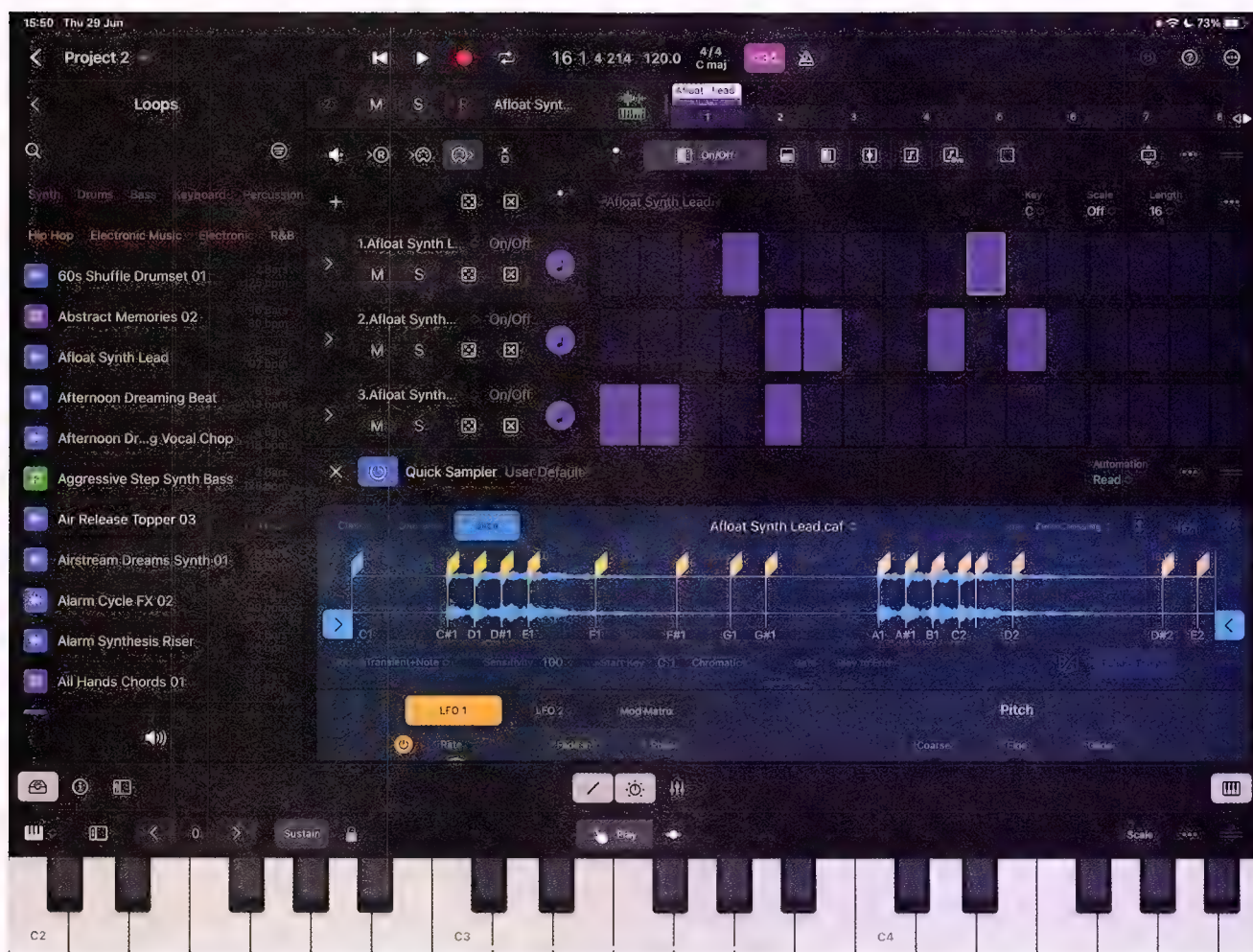
PLAY YOUR WAY

There are multiple touch-based ways to play including a keyboard, drum pads and chord pads. These can be further configured to behave the way you want, adding real-time controls like sustain.



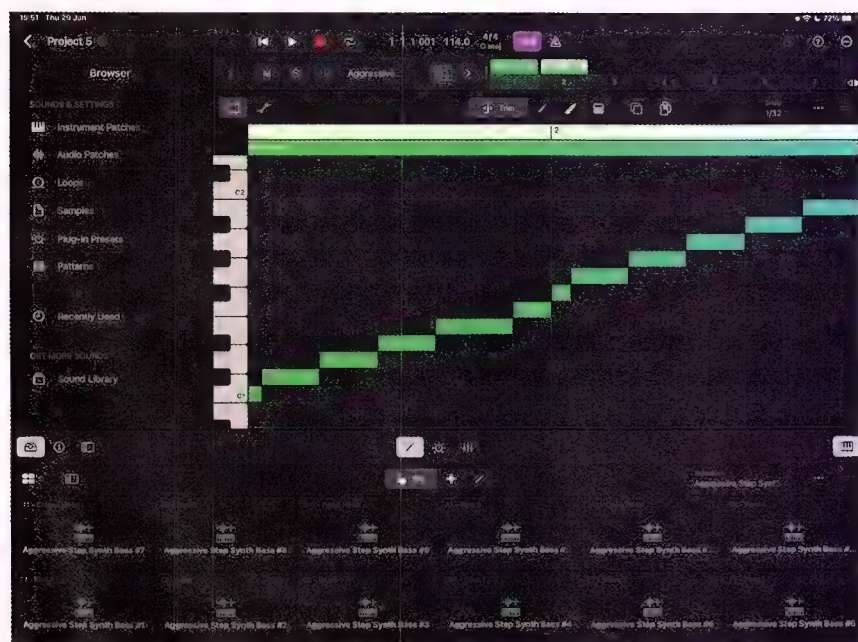
EXPORT FOR MIXING

While you can mix on the iPad, it's also possible to move to Logic on Mac, or export each track separately to mix on a different system entirely. This gives you plenty of options for finishing a project.



The interface lets you show and hide multiple elements easily.

"Logic's design is superb, doing away with windows in favour of a highly customisable interface that encompasses plug-in chains, a powerful mixer, arranger section, audio and MIDI editors and much more."



The touch interface is especially good for working with loops and MIDI patterns.

customisable interface that encompasses plug-in chains, a powerful mixer, arranger section, audio and MIDI editors and much more. You really can record, program, edit and mix whole projects in it, to a highly professional standard. You'll want to add an iOS-compatible audio interface for proper recording and monitoring and maybe a MIDI keyboard too, but the same is true of a laptop.

This is by some distance the most powerful and well-designed music app for iPad ever made. There's the odd niggle – iPadOS still limits you in a way macOS doesn't – and beginners will take a little time to come up to speed. And the subscription model will have its detractors too, it doesn't feel like something a company as rich as Apple really needed to do. But Logic Pro for iPad really does justify the 'pro' label, a slick and powerful app that will complement or even for some users replace the desktop version.

A hugely accomplished music production app for iPad that deserves the Pro label.

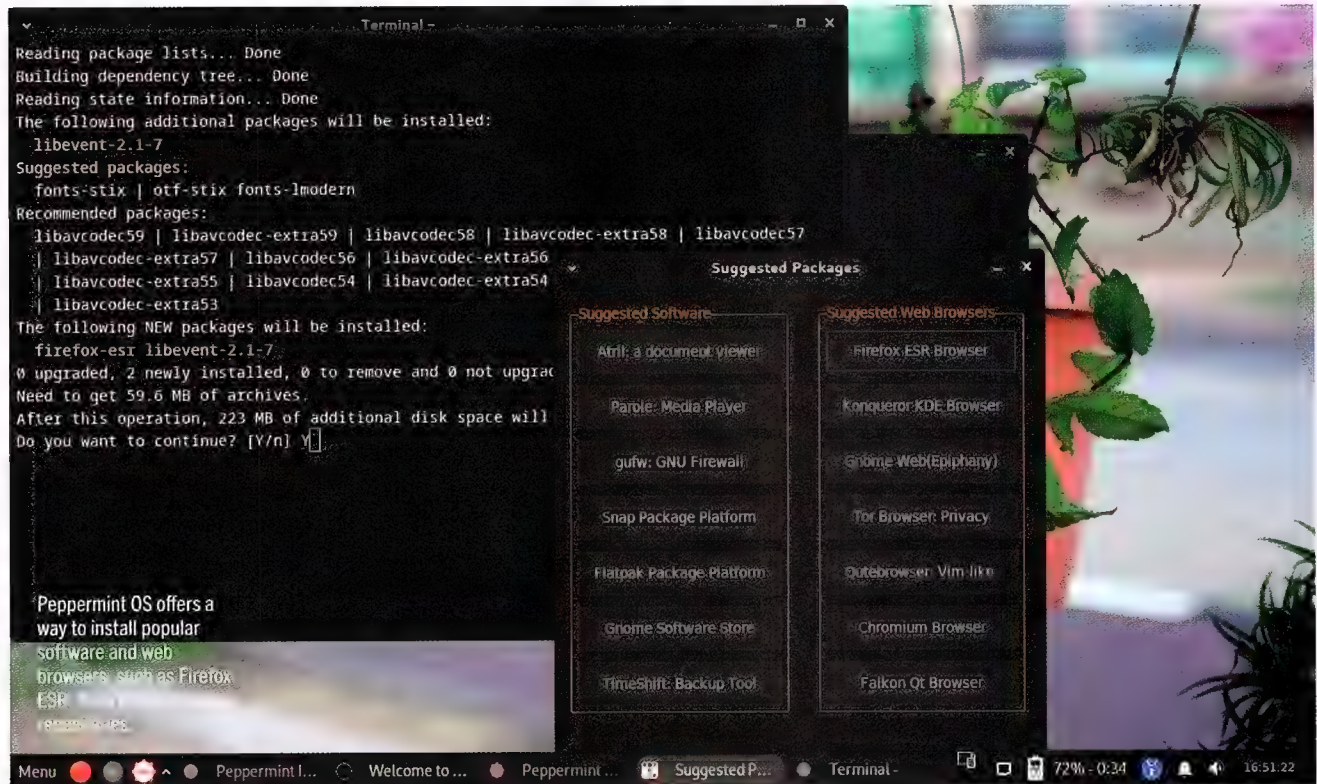
Hollin Jones

★★★★★

PEPPERMINT OS

After years of sampling Linux Mint, Nate Drake opts for something spicier in the hybrid Peppermint OS, which integrates cloud-based apps.

■ Licence GPL | <https://peppermintos.com>



Like many great ideas, Peppermint OS was conceived after a night in the pub. If you're wondering about the moniker, one of the lead developers, Kendall Weaver, also works on Linux Mint. The name itself comes from the creators' desire to build on Mint's success but also add web integration, hence the extra zing of 'Peppermint'.

The project has had a mixed history, previously being based on Ubuntu and incorporating elements of the LXDE desktop environment. These days, however, there are two main branches of Peppermint. One is based on the Debian fork (Devuan), while the version that forms the basis of this review is based on the most recent stable release of Debian itself (Debian 12 Bookworm). It uses the lightweight Xfce desktop environment and the inimitable Thunar file manager.

Although the ISO weighs in at around 1.5GB, on first boot you'll find there are very few pre-installed apps. This is because Peppermint has a hybrid desktop that uses both cloud and local apps. The OS contains Kumo, which can be used to launch SSBs (site-specific browsers). This means a dedicated browser window is assigned to specific cloud-based applications. The latest version of Kumo comes with an updated GUI and is based on the universal Lua programming language.

This can sound a little daunting but Peppermint makes an effort to hold your hand. If you boot into the live desktop environment, you'll see the Peppermint Hub, which has a list of suggested apps to install. This facilitates you downloading the latest version of certain apps from Debian repositories. However, if you want to install apps from Peppermint's own repos, you need to update the Sources file yourself manually.

If you're happy with what's on offer, the latest version of Peppermint has now judiciously divided this into two sections: Suggested Software and Suggested Browsers, presumably to make the layout simpler – we used the latter to install Firefox ESR.

You can also launch the Synaptic package manager or download and set up GNOME Software. The updated Welcome screen is, in fact, one of the features in the latest version of Peppermint.

The most recent iteration of the OS, version 2023-07-01, has also updated its Pep Docs, to help ease new users into the distro's way of working. This is where we learned about hblock, a super version of the regular hosts file found in Debian and its derivatives. It includes a list of domains that are known for serving ads, tracking scripts and malware, and prevents your cloud-based apps from connecting to them.

The Pep Docs also mention the bundled XDaily tool, a command-line system updater/upgrader that, once launched, only requires you to answer Y/N to perform routine tasks such as updates, removing old caches and updating your icon cache. You can also launch this using the handy little blue icon in the system tray.

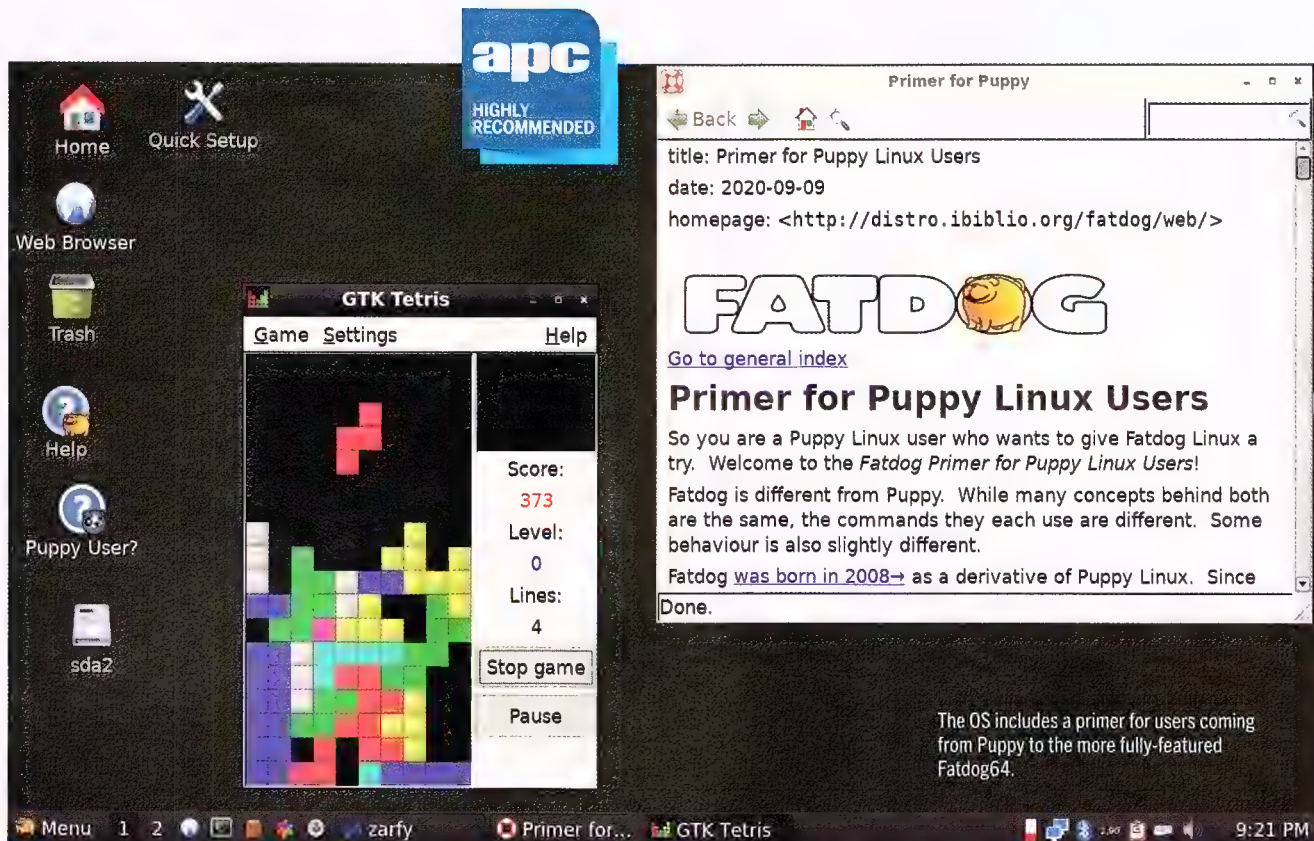
The help guide also points out the range of different packages the OS supports, though it's down to you to work out which is best for your Peppermint hybrid desktop. Speaking of the desktop, the latest version of Peppermint uses the Marawait theme and Tela icon set. These circular icons are particularly easy to tell apart from the quick-launch bar at the bottom-left.

If you do decide to go ahead and give Peppermint a try, setup is a breeze via the Calamares installer. From there, though, you're pretty much on your own if you haven't previously initialised cloud-based apps. Luckily, if you need help, the team maintains a thriving forum, Matrix channel and Mastodon page.

Peppermint is stunning and very easy to install but the job of setting up SSBs might be too daunting for newcomers.

Nate Drake

★★★★☆



FATDOG64 LINUX 814

Nate Drake decides to look in on Fatdog, a Puppy-based OS that's grown into a very credible canine in its own right.

■ Licence GPL V2 | <http://distro.ibiblio.org/fatdog/web/>

Every dog has its day and for the team at Fatdog, there have been many. The project started out in 2008 as a simple extension of Puppy Linux. Any experienced Linux user will tell you that Puppy's designed to be lightweight and easy to use, but the number of customisation options and requirement to install extra software to have a workable OS make it unsuitable for beginners.

Fatdog (as the name suggests) is the pup grown up. Its developers have placed emphasis on a fatter – that means more bundled apps – version of Puppy, while remaining very fast and efficient.

We couldn't see any better proof of this than when downloading one of the latest versions (814) of Fatdog, as the ISO weighed in at just over 500MB. The OS is also compatible with pretty much any computer using an Intel/AMD CPU released since 2008. On first boot, we chose to load the OS in Throwaway mode, which means into RAM but, like Puppy, you can install to a drive if you prefer. If you do this, Fatdog can store its settings in your existing FAT, Ext2/3/4, NTFS partition using two simple files – no partitioning required.

On first boot, it's clear the team has lived up to its claim of having a desktop ready to use. Incidentally, the desktop environment uses the extremely

versatile and lightweight Openbox. The official web browser is SeaMonkey (v2.2.2), though we noted the Internet menu also lists Firefox and Chrome, which can be installed via a mouse click.

There's a host of video and sound editing tools, and we were particularly impressed to see the latest version of VLC. Productivity apps include LibreOffice Writer, Calc and Impress, as well as the Evince PDF viewer. Fatdog also includes a range of image-editing tools, including the lightweight mtPaint and GIMP.

If you want to install extra software, Fatdog packages come in two flavours. The first is TXZ and operates along the same lines as Slackware, in that it contains a single compressed file with all the application data. (The Fatdog team stresses, though, that not all Slackware packages are fully compatible with the OS.) The other package type is SFS (Squash File System), the same as that used by Puppy Linux. It can contain multiple applications and libraries.

While Fatdog has become an independent and powerful distro in its own right, it isn't fully off the leash from its Puppy masters. The OS even comes with a primer (also available online) for Puppy users about how to make the transition.

Fatdog doesn't have its own dedicated forum but relies on a subforum on the Puppy Linux website (<https://forum.puppylinux.com/viewforum.php?f=60>). This is where we discovered that the release of Fatdog 64 814 will be the last in the 800 series. It contains minor improvements over the previous version, such as being based on version 5.19.17 of the Linux kernel. Other updates include the most recent versions of VLC and SMB, as well as Avidemux 2.8.1. There have also been minor tweaks to the Bluetooth Manager and the inclusion of a new Geany themes bundle.

The Fatdog team never fails to surprise, as simultaneous to its announcement of the latest stable 800 series came the news that it's releasing an alpha build of Fatdog 900. The team claims to have been using it behind the scenes for several months. It can only be installed, not upgraded to, but improvements over Fatdog 814 include a full system rebuild with brand new package repos. Head to <https://distro.ibiblio.org/fatdog/web/latest.html> to find out more.

Fatdog lives up to its name, being a derivative of Puppy that just works straight out of the box.

Nate Drake

★★★★☆

THE BEST FREE PC SOFTWARE YOU'LL NEVER HAVE TO PAY FOR

Don't get tricked by 'free' programs that will eventually charge you. Robert Irvine recommends the best truly free tools from independent developers you can trust.

It's always annoying when one of your favourite free programs becomes 'freemium'. This means you have to pay to use certain features, are restricted in what you can do with the software and have to put up with nags to upgrade to the paid-for version.

A recent example is Icecream Video Converter (www.snipca.com/47056), which now adds a watermark to every video you convert - unless you pay US\$29.95 a year for the Pro edition. Although companies are entitled to charge for their products, we think changing their policies once they've got you hooked is cynical and unfair.

Thankfully, not all software makers are as devious or greedy. Many independent developers, particularly members of the open-source community, create free tools for the love of doing so as well as to benefit other people. In this feature, we recommend the best programs that are

highly unlikely to introduce paid-for plans.

We've excluded open-source software you probably use already, such as LibreOffice, VLC Media Player and Mozilla Thunderbird, to focus on free tools you may not have heard of but we think you'll love. Our criteria for inclusion were that the programs must have been updated in the last year, that they won't disappear overnight and that they don't make money by collecting and selling your data.

- Because these tools are from small developers, they may trigger a SmartScreen warning from Microsoft Defender (or your other antivirus software). We've checked all our recommendations using VirusTotal (www.virustotal.com) to ensure they're safe, so just click 'More info' then 'Run anyway'.

WHAT CAN YOU DO

- Find duplicate files and delete them without paying
- Uninstall unwanted software and browser extensions
- Detect and update outdated device drivers for free
- Download YouTube videos without restrictions or upgrade nags
- Edit and play audio files using open-source software
- Delete text and images from PDF files for free
- Save online content without using your browser

SYSTEM TOOLS YOU'LL NEVER HAVE TO PAY FOR

Find and remove duplicate files on your PC

Freemium duplicate finders – such as Easy Duplicate Finder – are a particularly frustrating type of software. After scanning your hard drive for unnecessary copies of files, they then limit the number and type of items you can view and remove for free.

For a truly free alternative, try the open-source tool Czkawka (www.snipca.com/47013), which searches faster and deeper than any duplicate finder we've used. Add the folders or drives you want to scan, then select the 'Check method' and click Search – 'Hash' finds files with matching contents, or you can look for items of the same name and/or size.

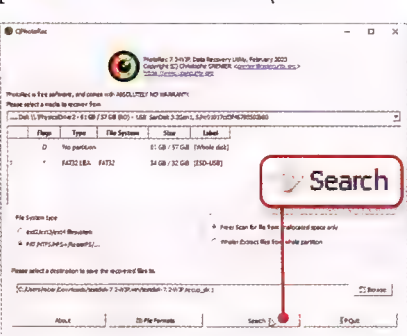
Czkawka also lets you search for similar images (see screenshot above right), which you can preview in a panel on the right, as well as videos and audio files, empty files and folders, and more. Duplicates can be deleted or moved to another location.

Downloading the program is a little confusing – even by GitHub's standards. Visit the Releases page (www.snipca.com/47014), click 'Show all 15 assets' in the Assets section for the latest version (6.0 at the time of writing) and select 'windows_czkawka_gui.zip'. Extract the contents of the ZIP file, and double-click 'czkawka_gui.exe' to run Czkawka.

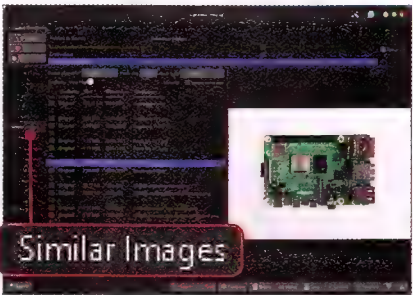
In case you're put off by the program's odd name, 'czkawka' is Polish for 'hiccup' – the developer was intrigued to hear how non-Polish speakers would pronounce it!

Recover lost photos and documents for free

Most file-recovery tools restrict how much data you can restore without upgrading to their paid-for versions. Recuva (www.snipca.com/47011)



Use PhotoRec to recover lost files without paying for the privilege.



Czkawka is a thorough duplicate finder that doesn't charge you to delete files.

www.snipca.com/47016) is a notable exception, but it's been neglected since Avast bought its developer, Piriform, and some features are only available in its Professional edition.

The best free open-source option for recovering data is PhotoRec (www.snipca.com/47017), which despite its name doesn't only restore deleted photos. It can scan hard drives, USB sticks and memory cards for lost videos, documents and EXE files, and recover them even if the device has been formatted.

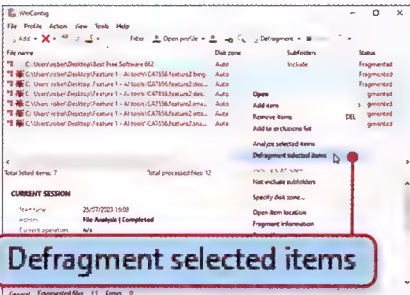
You need to download PhotoRec with its sister program TestDisk, which restores lost partitions. Extract the contents of the ZIP file then double-click the 'qphotorec.exe' file – this adds a user interface to the command-line tool and is only available in the latest version (7.2).

Select the drive you want to scan in the dropdown menu, then the relevant partition and specify whether you want to search only unallocated space or the whole partition. Choose the folder you want to restore files to, and click Search. PhotoRec will then find and recover all files deleted from that partition – it's extremely thorough, so the results may take you a while to sift through.

Defragment specific files and folders

Although Windows has its own tool for defragmenting your hard drive, it restricts you to defragging entire partitions, which can take a long time. Sometimes you only want to defrag a specific file, folder or program to consolidate its data, free up space and make it open more quickly.

Defragging specific items was one of Defraggler's most useful tools, but that program was ruined when Avast bought Piriform – it hasn't been updated for five years. A much better option is WinContig (www.snipca.com/47011), which lets you easily



Defragment specific files and folders on your PC for free using WinContig.

defragment files and folders by right-clicking them and choosing 'Defragment selected items' (see screenshot above).

To add this option to File Explorer's right-click menu, click the Tools menu in WinContig and choose 'Install the shell extension'. The program supports FAT32 and NTFS file formats, and works with hard drives and SSDs (though items on the latter shouldn't need defragging). It's the developer's only program, and is supported by donations rather than adverts.

Completely uninstall unwanted software

Finding the perfect free program to remove other software from your PC is trickier than you'd think. Some tools, most notably Revo Uninstaller, restrict useful features to their paid-for versions – including Force Uninstall, cleanup of leftover files and removal of browser extensions.

Others, such as the brilliant O&O AppBuster (www.snipca.com/46027) are very easy to use, but are owned by companies that also sell commercial products, so there's no guarantee they'll always be free.

We often recommend BC Uninstaller (www.bcuninstaller.com) as the most powerful tool of its kind, but if you find its feature-packed interface intimidating then HiBit Uninstaller (www.snipca.com/47008) might be a better choice. It's friendlier and faster than BC Uninstaller, letting you remove multiple programs in one go simply by ticking their boxes and clicking Uninstall Selected.

Many additional options are available in the Tools menu including Force Uninstall, Junk Files Cleaner and File Shredder, as well as tools for removing Microsoft Store apps, Windows updates and browser extensions. These are all free to use, with nothing locked behind an



HiBit Uninstaller makes it easy to completely remove unwanted programs.

Upgrade button.

HiBit Uninstaller's developer, Mohammed Raei, has a couple of other programs, including the equally useful HiBit Startup Manager (www.snipca.com/44640). However, he gives this one the most attention and – unlike Piriform – we can't imagine he'll ever sell out to a big corporation.

Install and update multiple programs at once

When companies offer free versions of their commercial software for personal use, there's always a risk they'll eventually ditch them. Such is our fear over the popular program updater Patch My PC (<https://patchmypc.com>), which is free to home users but costs from \$1,499 (£1,160) for businesses that want to keep all their employees' software up to date.

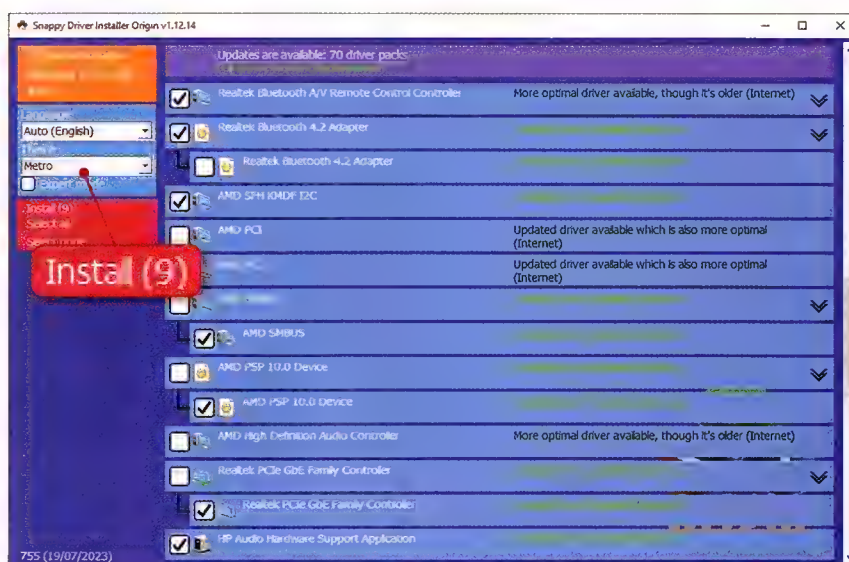
In fairness to Patch My PC, its free Home Updater has been available for 12 years, but as a backup plan we recommend WingetUI (www.snipca.com/46556). This free open-source tool allows you to install thousands of programs through the Windows Package Manager and other package managers including Chocolatey and Scoop.

As well as searching WingetUI's massive software directory on its Discover Packages tab, you can check for updates for programs you already have installed, just like in Patch My PC. On the Software Updates tab, tick the 'Select all packages' box (see screenshot below) then click 'Update selected packages' to check for and install updates.

Keep your device drivers up to date



WingetUI offers a simple free way to install and update all your software.



Snappy Driver Installer Origin offers a free way to update your device drivers.

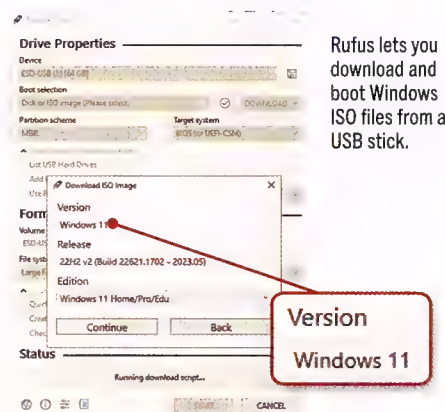
Driver managers are another type of software that does half a job for free – scanning for outdated device drivers – then charges you to do the other half (actually updating them). Some, such as the dreadful IObit Driver Booster, also come bundled with junk and advert for the company's other products.

One of the only driver updaters you can trust is the open-source Snappy Driver Installer Origin (SDIO, www.snipca.com/47015), which is completely free to use and free of junk and ads. Its developer emphasises this fact on its website, so don't be fooled by similarly named tools that ask you to pay – and may contain malware.

If you're unfamiliar with SDIO, you first need to install its 20MB indexes pack, which scans your PC to detect which drivers need updating. You can then review the results and decide which ones to update, before clicking the Install button (see screenshot above) – make sure you create a system restore point first. Recommended drivers are highlighted in bright green – ignore older and unsigned drivers that are shown in red.

Create a bootable version of Windows on a USB stick

Keeping a portable version of Windows on a USB stick allows you to reinstall the operating system if something goes wrong with your PC. Rufus (www.snipca.com/47012) is our favourite free tool for creating bootable USB drives and is frequently updated to make it easier to use and to bypass restrictions such as Microsoft's strict requirements for running Windows 11.



Rufus lets you download and boot Windows ISO files from a USB stick.

We also like that the developer behind Rufus, Pete Batard, is very honest about how he manages to keep the program free – and always will. On the Rufus website, he explains that he doesn't use a donations system like other open-source programmers, because it can be "guilt inducing" for users, and instead relies on revenue from the two ads on the homepage (there are none in Rufus itself).

"The fact I have the freedom to develop free software in my spare time should indicate that I'm well-off enough," Pete says, thanking users for their "continuing support and enthusiasm about this little program".

To use Rufus, download an ISO file for an operating system from an official source, choose 'Disk or ISO image' in the 'Boot selection' menu and click Select to load it. Alternatively, click the arrow next to that button, choose Download and select the version of Windows you want to install (see screenshot above). Click 'Start' and, Rufus will erase and format your USB stick, and burn the ISO file to make the drive bootable.

VIDEO & AUDIO TOOLS YOU'LL NEVER HAVE TO PAY FOR

Download videos from websites for free

Free video downloaders are often too good to be true and hampered by hidden restrictions – unless you pay. Even the free version of the excellent 4K Video Downloader (www.snipca.com/46993) limits you to downloading 30 videos a day, one at a time. To unlock unlimited downloads and extra features, you need to pay US\$18 a year for its Lite plan or \$25 for Personal.

What's more, there's now a new version called 4K Video Downloader+ (www.snipca.com/46991), with a streamlined design and 'enhanced' features. Although you can use this for free (with restrictions), its paid-for editions require you to buy a new licence, even if you have one for the old version. The original 4K Video Downloader will remain available but will no longer be updated.

Saddened by 4K Video Downloader's aggressive promotion of its commercial software, we've turned instead to Viddl (www.snipca.com/46995). This new open-source tool lets you download videos from hundreds of websites – including YouTube – for free, with no limits on the number of daily downloads.

Simply click the Add New Videos plus sign (1 in our screenshot below), paste the URLs of the videos you want to save and click Settings to specify the download format (2, such as AVI, MP4 or MKV). Click the Download tab to set the maximum number of concurrent downloads (up to eight), then click OK and the respective download buttons to save the videos.

Viddl isn't as slick as 4K Video Downloader+, but it's easy to use, downloads videos quickly and

doesn't restrict any options to a paid-for version – because there isn't one.

Convert videos to play on different devices

Video converters are also notorious for restricting features to their paid-for versions, often without making this clear until you try an option. We've already mentioned how Icecream Video Converter recently started charging users to remove its watermark. Other freemium tools, such as Any Video Converter, limit the quality, length and/or formats of the videos you convert.

For a truly free video converter that doesn't charge you and never will, we recommend HandBrake (www.snipca.com/46990). This versatile, open-source tool has been around for 20 years and was most recently updated (to version 1.6.1) in January. It can convert virtually any video, including content from unprotected DVDs and Blu-rays, to the widely used formats MP4, MKV and WebM, and includes handy presets for converting videos to watch on different devices. These include settings for Android, Apple and Amazon Fire, as well as for email, social media and YouTube.

To use the program, click 'File' on the Source Selection screen (click Open Source if you don't see this), choose a video and HandBrake will show you a preview of its contents. Click the Preset menu to choose a format and quality to convert to, specify the folder where you want to save the converted video and click Start Encode (see screenshot above right).

Record and edit audio files privately

Our favourite audio editor, Audacity (www.audacityteam.org), has raised privacy concerns since it was bought by Muse Group in 2021.

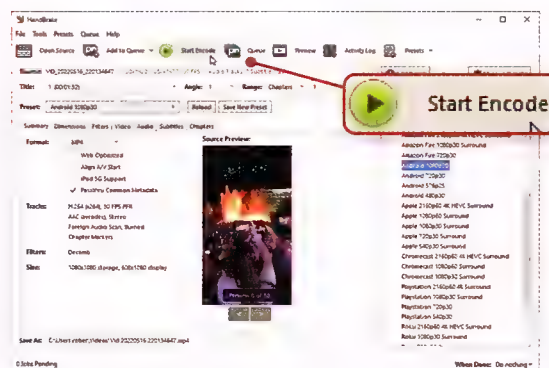
Also, although it remains free and open source, Audacity is now integrated with Muse Group's audio-sharing platform Audio.com. This makes it easy to share files with other people, but because you need to create a free account with the

HandBrake offers a completely free way to convert videos and will never charge you.

service, you'll lose your anonymity by doing so.

To get all the benefits of Audacity without passing your data to the 'Muse Group family', install Tenacity (www.snipca.com/47002) instead. Last time we wrote about this Audacity fork, it was still in beta, but it's since released its first stable version (1.3). Tenacity is based on the last version of Audacity before it was bought by Muse Group and looks almost identical, with all the same options for recording, editing and enhancing audio files, but none of the privacy worries.

To download Tenacity, visit www.snipca.com/47003 and click one of the 'exe' links under Downloads. The program opens in its default dark theme, but you can change this by clicking Preferences in the Edit menu (see screenshot below) and choosing a different theme on the Interface tab.

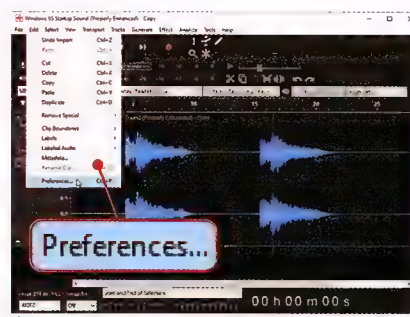


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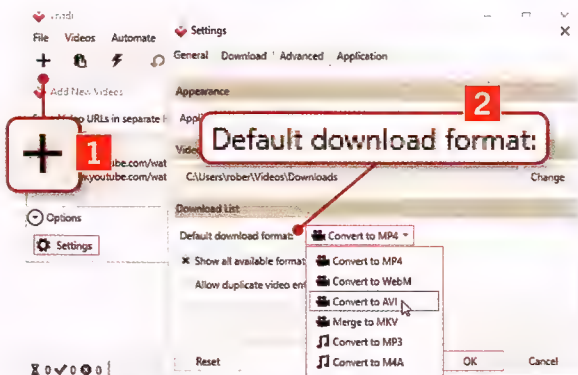
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Tenacity is a customisable fork of Audacity and not owned by a data-gathering company.

Play audio files and rip CDs for free

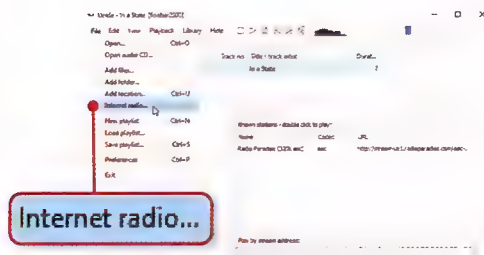
The highly anticipated comeback of Winamp (www.winamp.com) in April was a major disappointment. Rather than release a new version of the popular audio player, which had only been updated sporadically over the previous 10 years, Winamp's owner Llama Group relaunched it as a streaming service.



Download web videos without restrictions using the open-source tool Viddl.

This lets you listen to radio stations, podcasts, audiobooks and music by Winamp 'creators', but you can no longer play audio files stored on your PC. You also need to pay €50 (~\$84) a year to subscribe. Although the most recent version of the free desktop program (5.9.2) is still available from www.snipca.com/47019, it may eventually be removed.

Thankfully, there are two similar alternatives to Winamp that are guaranteed to remain free. One is AIMP (www.aimp.ru), but as this has a Russian developer you may feel more comfortable using Foobar2000 (www.foobar2000.org). This open-source audio player has been



Foobar2000 lets you play your own music and internet radio stations for free.

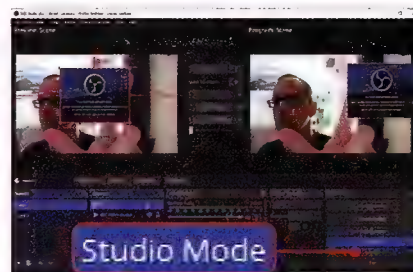
around for nearly 20 years, but is still in active development and supports all the main audio formats.

Foobar2000 lets you play and rip songs from CDs, stream internet radio stations (see screenshot below left) and tag tracks with information from an online database. It's not immediately obvious how to use all its features, but you'll find plenty of help in its wiki (www.snipca.com/47021) and subreddit (www.snipca.com/47022) pages.

Record and stream videos for free

 Software for recording and streaming your own videos can be very expensive – for example, HitPaw Screen Recorder costs US\$50 so it's amazing that OBS Studio (www.snipca.com/47023) won't cost you a cent. Maintained by open-source volunteers, but far more professional-looking than your average GitHub project, this powerful broadcasting tool has no watermarks or other limitations and can be used commercially without any restrictions.

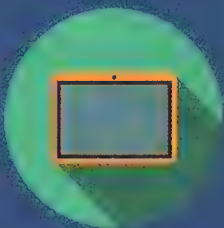
OBS Studio lets you capture and stream video from a variety of



OBS Studio is packed with features and is the best free way to record and stream your own videos.

sources, including movies stored on your PC, content that's playing in your browser and the live feed from your webcam. You can apply a wide variety of edits and effects; mix multiple sources into one broadcast and preview them using Studio Mode (see screenshot above); stream directly to YouTube, Twitch and Facebook Live; and save files in MP4, MKV or FLV format.

Indeed, our only criticism of OBS Studio is that its many options mean it has a fairly steep learning curve. Visit its comprehensive Knowledge Base (www.snipca.com/47024) if you get stuck.



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PHOTO & PDF TOOLS YOU'LL NEVER HAVE TO PAY FOR

Edit and enhance photos more easily

There are plenty of free image-editing programs for keen photographers who can't afford Adobe Photoshop. But some, such as GIMP (www.gimp.org), have so many advanced tools that they're not easy to use. APC's favourite Paint.NET (www.getpaint.net) is a slightly simpler alternative, but it's not open-source and, although its desktop software is free, its Microsoft Store app now costs \$14.95.

One image editor that strikes the right balance between professional features and ease-of-use, as well as being free and open-source, is PhotoDemon (www.snipca.com/47025). This powerful, portable program resists the urge to cram its toolbars with options you'll never need, so editing and enhancing your photos is more intuitive than in GIMP or Paint.NET. It offers the same basic tools, including layers, adjustments and a wide range of effects, but applies them faster and doesn't make you hunt through sub-menus to find them.

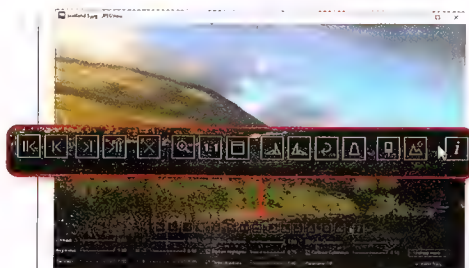
PhotoDemon 9.0, which was released last September, introduced a useful option called 'Content-aware fill'. This lets you remove unwanted objects and people from your photos, and seamlessly blend in the surrounding area to disguise the deletion. PhotoDemon says the feature doesn't "rely on 'AI' or other silly buzzwords", and works offline. To use it, click the Elliptical Selection tool, select the object you want to remove, then click the Edit menu and choose 'Content-aware fill' (see screenshot below).

Browse photos in a free image viewer

IrfanView (www.irfanview.com) is one of the best image viewers available. It's simple



PhotoDemon is free and easy to use, and has lots of useful image-editing tools.



JPEGView provides a simple free way to browse and adjust your photos.

to use, includes lots of editing tools and lets you expand its capabilities by installing plug-ins (www.snipca.com/47026). IrfanView has been free for home users since its launch in 1996, but to use it for commercial purposes you need to register the program and buy a licence for US\$12, so it doesn't meet the 'never pay for' criteria of this feature.

JPEGView (www.snipca.com/47027) is a truly free alternative. Originally developed through the open-source community SourceForge then taken up by a GitHub developer, this lightweight, portable image viewer offers a speedy and minimalist way to browse and perform basic edits to your photos.

Open a picture in JPEGView and all you'll see is the image itself – there are no toolbars or menus. This is confusing at first, but hovering your cursor over the photo or right-clicking it reveals options to zoom, rotate, display EXIF information, apply auto-correction, view other files in the folder and more (see screenshot above). Move your cursor to the bottom of the image to reveal controls for fine-tuning its colour, brightness and contrast. Press Ctrl+S to save your changes.

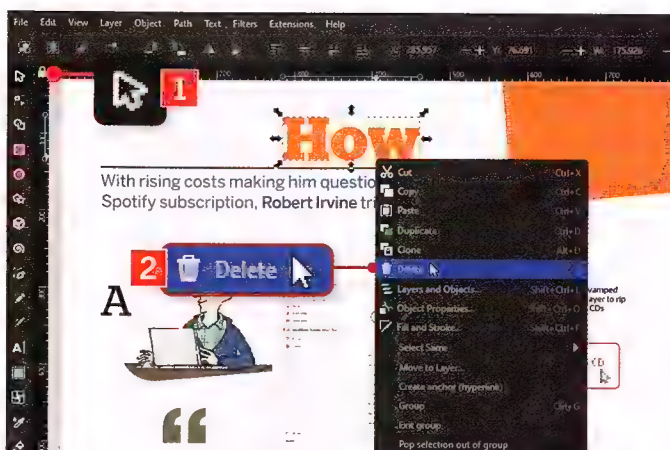
To download JPEGView, click the 'JPEGView_1.2.45.zip' link under Assets

on its Releases page (www.snipca.com/47028) and extract the contents of the ZIP file. Open the JPEGView64 or JPEGView32 folder (depending on whether you have a 64bit or 32bit version of Windows) then double-click the 'JPEGView.exe' file. Despite its name, it supports all the main image formats.

Edit PDFs by deleting and adding text and images

Free PDF readers aren't hard to find these days, from the built-in viewer in your web browser to the open-source tool Sumatra PDF (www.snipca.com/47029). PDF editors, on the other hand, tend to be paid-for or freemium, and we even have doubts about our new favourite free PDF software PDFgear.

The best entirely free way to edit PDFs, which you'll never have to pay for, is using the open-source vector-graphics editor Inkscape (<https://inkscape.org>). Although it's aimed at illustrators and web designers, this powerful program allows you to delete images and text from PDFs, and add your own. Install and launch Inkscape, click Open on the welcome screen and select a PDF. Leave the import settings as they are, then click OK. When the PDF opens, click the Selector Tool (the arrow icon) at the top of the left-hand toolbar (1 in our screenshot below), then select an object or block of text in the document. Right-click and choose Cut or Delete (2) to remove the selected element, or left-click and drag it to a different position. You can't edit existing text but you can replace a deleted section with a new text box by clicking the Text Tool (A icon) in the toolbar. To insert images, click the File menu and choose Import.



Inkscape's busy interface can feel overwhelming, but you'll find plenty of help in the Beginners' Questions section of its community forum (www.snipca.com/47030).

Inkscape lets you edit PDFs by replacing text and images.

INTERNET TOOLS YOU'LL NEVER HAVE TO PAY FOR

Monitor your Wi-Fi network for intruders

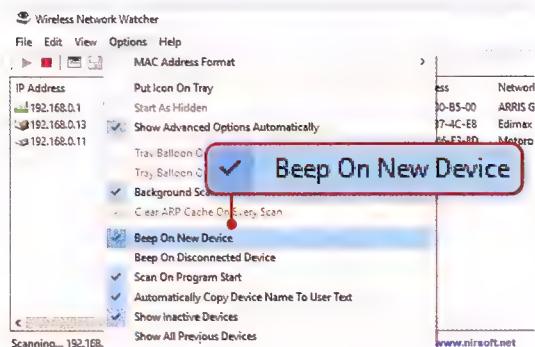


Fing Desktop (www.snipca.com/47032) offers a simple

way to monitor your home network and ensure that unknown devices aren't piggybacking on your Wi-Fi connection. Sadly, many of its best features are limited to its paid-for plans, which the free version (that you need to register to use) constantly reminds you about.

To monitor your network for free, without being nagged to upgrade for extra tools, download Wireless Network Watcher from NirSoft (www.snipca.com/47033) – click the 'wnetwatcher_setup.exe' link below the Feedback section two-thirds of the way down the page. This tiny free tool is only 512KB in size, compared with Fing Desktop's bloated 96MB download, but gives you all the information you need to identify Wi-Fi intruders.

Wireless Network Watcher lists all the devices connected to your network, including their names, IP addresses and the times and dates they were first and last detected. Usefully, you can set it to alert you



Wireless Network Watcher monitors your Wi-Fi and alerts you to intruders.

when a new device hops on your Wi-Fi – click the Options menu and select 'Beep On New Device' (see screenshot below left).

See the opposite page for more brilliant free tools from software genius NirSoft.

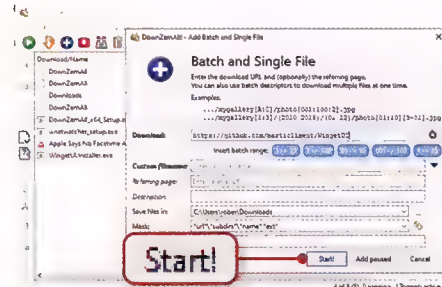
Download online content without a browser



Download managers such as JDownloader and Internet Download Manager are often bundled with junk or charge you to use them. Most of us now stick with our browser's built-in downloader, but this compromises your privacy – even in incognito mode, Google can see which files you download in Chrome.

DownZemAll (www.snipca.com/47039) is a free, open-source download manager that lets you grab anything you want from the web, without using your browser. To save an individual file, right-click its download link and choose 'Copy link address' then click the blue plus sign on DownZemAll's toolbar. The program will automatically read the link from your clipboard, so you just need to click 'Start' (see screenshot above right) to download it.

You can download YouTube videos and other audio and video content by clicking the red Download Audio/Video Stream button, then clicking the yellow Download Page Content button to detect and download all the files on a web page – or just specific file types. DownZemAll is faster and more private than using your browser, and lets you compile a list of download links to save all their content in one go.



DownZemAll downloads files quickly and privately outside your browser.

When you install DownZemAll, tick the box to allow an exception in the Windows Firewall to prevent it from being blocked.

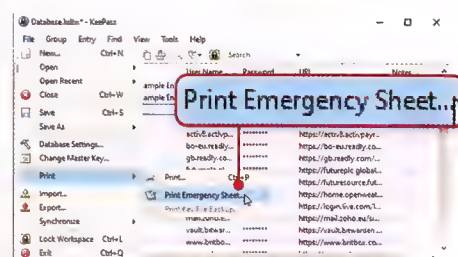
Protect your passwords for free



Even the best password managers, such as Bitwarden (<https://bitwarden.com>), restrict some features to their paid-for versions, and there's always the fear that – like LastPass – they'll change their business models to force free users to upgrade. You can be assured that will never happen with KeePass (www.snipca.com/47040), which makes a virtue of the fact it's been free for the last 20 years.

Far safer than storing website logins in your browser, this open-source tool stores all your passwords in one offline database, which is locked with your master key and secured using powerful encryption. It's worth printing an emergency recovery sheet should you forget your master password – click File, Print then select Print Emergency Sheet (see screenshot below).

The latest version of KeePass (2.54) fixed a vulnerability that could allow hackers to see part of your master password. Sadly, it didn't improve the program's rather dated interface. If you find this off-putting, consider using the forked version, KeePassXC (<https://keepassxc.org>), which has a smarter design but the same tight security.



Store all your passwords securely in KeePass – but click this to avoid getting locked out.

AVOID OPEN-SOURCE SECURITY TOOLS

We've deliberately not recommended open-source security software in this feature, even though there's plenty available. It's one area where it's better to have the program maintained by a reputable and well-funded company, rather than an independent developer, to ensure it's regularly updated to combat the latest threats.

Reliable anti-malware protection uses virus definitions hosted online, which most GitHub projects won't be able to afford. The best-known open-source antivirus, ClamWin, doesn't even scan files in real time, and its website now displays a security warning, suggesting it's been discontinued.

Additionally, hackers can analyse the publicly shared code for open-source software to identify and exploit security flaws. Your antivirus should protect you against this danger, but if the program itself is compromised, your PC will be at serious risk.

5 BEST FREE TOOLS FROM NIRSOFT

We've covered software from lots of independent developers in this feature, but none are as industrious or ingenious as Nir Sofer – better known as NirSoft (www.nirsoft.net). This prolific Israeli developer has created hundreds of tiny free tools for performing specific tasks on your PC, which contain no junk, ads or upgrade nags.

Here are our five favourite programs.

Recover lost Wi-Fi passwords

 **WirelessKeyView** (www.snipca.com/47048) reveals all the Wi-Fi passwords stored on your PC, which is useful if you've lost the written record of those details. You can copy individual keys to your clipboard (see screenshot below) or export them all as a text file. To extract the program from its ZIP file, enter the password WKey4567# when prompted.

Detect nearby Bluetooth devices

 **BluetoothView** (www.snipca.com/47041) monitors the activity of nearby Bluetooth devices such as phones, earbuds and laptops. As with Wireless Network Watcher (see opposite page), you can set it to beep when it detects a device, which NirSoft suggests could alert you to the impending arrival of a family member or neighbour.

View your complete browsing history

 **BrowsingHistoryView** (www.snipca.com/47049) displays the history from all your

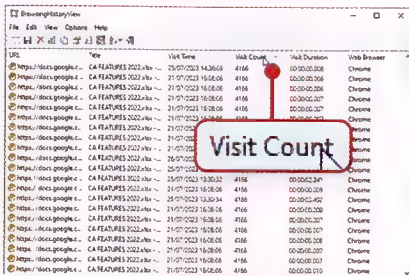
WHICH FREE TOOLS MAY BECOME FREEMIUM

We're currently anxious about the free PDF software PDFgear (www.pdfgear.com). This fantastic new program offers so many useful tools for free – including editing, converting, splitting, merging and annotating PDFs – that it surely won't do so forever.

Indeed, the company says that "as we continue to innovate and develop advanced features, we will offer these at a reasonable price, ensuring PDFgear remains accessible to everyone," which has 'freemium' written all over it. Hopefully, it won't lock any of the existing options behind upgrade buttons.

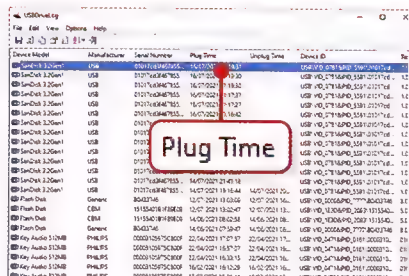
Another likely candidate for freemium status is Icecream Photo Editor (www.snipca.com/47053). It's now the developer's only tool not to have a paid-for Pro version, so it's only a matter of time before a watermark or other restriction is imposed on the free program.

We're more confident that PowerToys (www.snipca.com/47054) will remain free. Although Microsoft likes to lure users with free trials before enticing them to subscribe, the fact it's made PowerToys open-source on GitHub (www.snipca.com/47057) suggests you'll never have to pay for the system-utility suite.



BrowsingHistoryView lists pages you visited in all browsers, giving totals for each page.

browsers in one place. Click the Visit Time column to sort the list of web pages chronologically, or Visit Count (see screenshot above) to see which sites you've been to most often. The tool was recently updated with the option to



USBDriveLog reveals which USB sticks have been plugged into your PC.

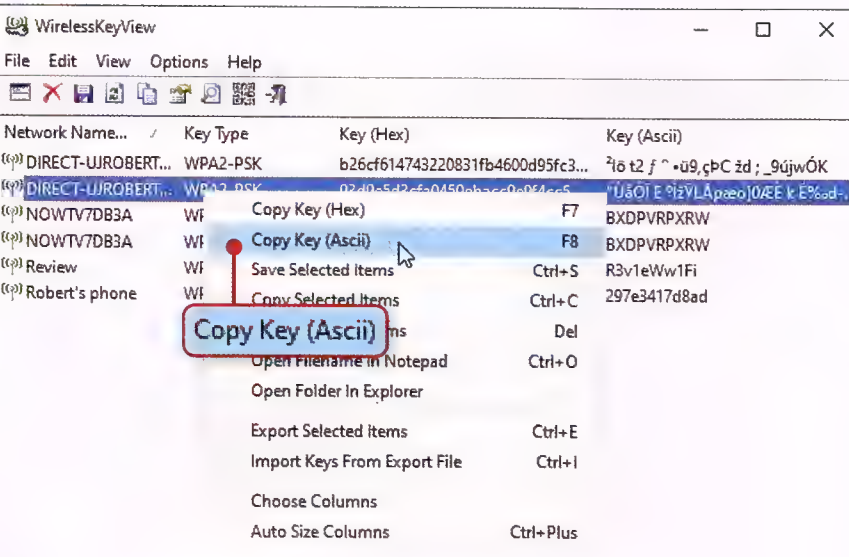
generate scannable QR codes for pages in your history.

Finely control your PC's sound

 **SoundVolumeView** (www.snipca.com/47050) lets you view and easily adjust the volume levels of different components on your PC, including the speakers, webcam microphone and system sounds. You can increase or decrease their volume by one, five or 10 per cent; and mute or unmute specific devices with a single click.

Monitor your USB stick activity

 **USBDriveLog** (www.snipca.com/47052) lists all the USB sticks that have been inserted in your PC, including their models, manufacturers and capacities, and the date and time they were plugged in (see screenshot above). This lets you see when you last inserted a specific device, and spot unauthorised use of your PC – including potential data theft. ■



WirelessKeyView reveals forgotten Wi-Fi passwords stored on your PC.

Home computers in Australia, a fast history

Part 5: A computer in your pocket. They were computers so small, they dropped jaws around the world. But despite their apparent demise in 1987, the 'pocket computer' era continued well into the new century **Darren Yates** writes.

**PART 5
OF 5. NEW
SERIES BEGINS
NEXT ISSUE!**

Tandy Electronics is well known as one of the three pioneering brands (along with Commodore and Apple) that brought the world the 'home computer' in 1977. But three years later, Tandy also helped usher in what was, at the time, such a jaw-dropping moment it was considered all but impossible - a programmable computer that fitted into your pocket. These 'pocket computers', some powered from just a couple of coin-batteries, were considered the stuff of the 'space age', so much so, that Tandy Electronics brought in famed science-fiction author Isaac Asimov to spruik them in Tandy ads.

However, the fanfare lasted only a few years before Tandy quietly dropped the concept in 1987.

This is the story of how it began - and what happened next.

Miniaturisation

As we've seen, the 1970s was an incredible era for electronics. Large-scale integration (LSI), the process of squeezing thousands of



Above: Hewlett-Packard's HP-71B had a 22-character display with 18KB of memory and ran off four 'AAA' batteries (Public Domain).

transistors into a single integrated circuit (IC) chip, made possible the microprocessors that created the home computer market. An important aspect of these CPUs, including the MOS Technology 6502 and Zilog Z80, was their comparatively low power consumption. Rather than needing a dedicated three-phase hook-up to the local power grid, home computers used less power than a 40-watt light globe and it's one of the unheralded but most

important reasons why home computers were possible at all.

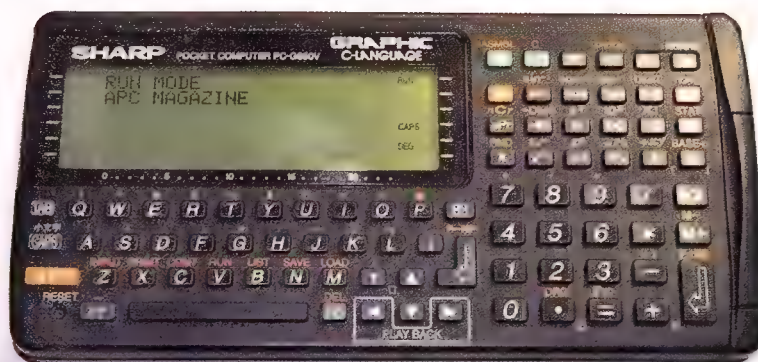
It was also the era the Japanese electronics industry made its own. As we've seen previously, Japanese giant Sony had taken the compact cassette to new heights in 1979 with the 'Walkman' and the nation's engineering skill in miniaturisation was fast gaining global attention.

But Sony wasn't alone in this new race. Another Japanese company, Sharp Electronics,

Below: Sharp launched the first battery-powered pocket calculator, the EL-8, in 1971 (Image credit: Mister rf, CC BY-SA 4.0).



Above: Swedish maker Facit developed mechanical multiplying machines in the 1950s (Image credit: Hannes Grobe, CC BY-SA 2.5).



likely gave Commodore boss Jack Tramiel heartburn in the electronic calculator business. Mechanical calculators had been replaced by mains-powered electronic calculators during the 1960s, but it was Sharp who introduced the first battery-powered pocket calculator, the EL-8, in 1971 and two years later followed it up with the first LCD pocket calculator, the EL-805.

While the U.S. gains most of the fanfare in terms of early processor designs, it wasn't a monopoly. The Nippon Electric Company, better known to the world as 'NEC', began in 1899 as a telephone company before moving into radio communications in the 1920s and electronics after WWII. In December 1971, the company created its first microprocessor design, a 4-bit two-chip set called the uPD707/uPD708. By 1973, the two chips had become one in the uPD751, consisting of 2,500 transistors operating at a clock speed of up to 2MHz. It was this CPU Sharp tapped four years later to drive its first programmable calculator dubbed the PC-1200 'pocket computer', powered by two AA batteries. Although it included a numeric keyboard only, the PC-1200 would just be the start.

Complementary Metal-Oxide Silicon

Up to this point, the technology underpinning microprocessors – the transistor switches that drove them – was still comparatively power-hungry. However, back in 1968, Radio Corporation of America (RCA) developed the 4000-series CMOS logic family of integrated circuits (ICs) and it dominated low-power digital logic development during the 1970s. While the chips were slower than the competitor TTL (transistor-transistor logic) ICs,

CMOS power consumption was comparatively non-existent. At this point, power consumption in home computers wasn't a primary issue and it wasn't until Sharp looked to expand its PC-1200 into something bigger that the CMOS CPU began to take centre-stage.

Enter the TRS-80 Pocket Computer

In July 1980, Tandy Electronics introduced the world to that 'something bigger' – the Sharp PC-1211, rebadged as the new Tandy TRS-80 Pocket Computer. It featured two new Sharp 256KHz four-bit CMOS processors, the SC43177 and SC43178. In combination with a single-line 24-character LCD, the PC-1211 ran off just four MR44 button batteries, something hitherto unheard-of. What's more, the batteries were good for an impressive 200 hours. The PC-1211 featured Sharp's version of BASIC and its list of optional peripherals included tape storage and thermal printer. It sold in Australia in Tandy Electronics stores towards the end of 1980 for \$249 and a further \$49 for the cassette interface.

It's difficult today to imagine just how revolutionary it was – it was only 30 years prior that CSIRAC, Australia's first

computer, buzzed into life. Now, you had more processing power in your pocket running off a few watch batteries. By contrast, 28 years ago, we had laptops with Windows 95.

In 1983, the Sharp PC-1401 became the first pocket computer to incorporate scientific calculation functions and became the form-factor for future models from Sharp, Casio and even HP.

After Tandy

However, as the 1980s computer market shifted away from home computers to PCs, pocket computer sales declined and the Sharp PC-1246 became the last Tandy pocket computer, the PC-8, in 1987. For us in 'the west', this is where the story ended. In Japan, however, it had barely started.

Sharp just kept right on with development and sadly for Tandy (and us), the best was yet to come.

Sharp PC-E200 series (1988-1994)

The year after Tandy exited the market, Sharp delivered the vastly improved PC-E200. It was a departure from the rather-average PC-1246 in almost every respect. The PC-E200 featured 32KB of RAM and a new Z80-compatible processor designed using CMOS technology – that meant it could

Above left: The Sharp PC-E500S followed the E200-series with a 40-character/ four-line display (Image credit: Morn, CC BY-SA 4.0).

Above: The Sharp PC-G850 series was the last 'pocket computer', released in 2001 (Image credit: Darren Yates).

Below: The Sharp PC-1211 was the basis for the first Tandy Pocket Computer in 1980 (Image credit: Denisfo, CC BY-SA 3.0).





Above: The Sharp PC-1401 was the first programmable to include scientific calculations (Image credit: Darren Yates).

deliver decent processing speed and yet be powered by four AA batteries. Instead of the single line of 16-characters, the E200 provided a four-line display of 24-characters. The QWERTY keyboard remained, as did the scientific calculation functionality, but the original thin-metal/plastic case work was replaced by a new more-ruggedized plastic case and slide-on cover.

The E200 was followed up by the E220 in 1991. The 8-bit CMOS Z80-compatible CPU now topped 3MHz and in addition to BASIC programming, the E220 included direct Assembler coding to maximise CPU speed.

Sharp PC-G80x/G81x series (1988-2000)

The PC-G80x and PC-G81x series came out as cheaper versions of the E200 series that same year, typically featuring only 8KB of RAM, but still offering the 24-column four-line display. The key here seemed to have been reducing cost, with battery capacity of four AA cells. The PC-G801 appeared in 1988,

followed by the PC-G802 in 1990, adding Assembler language coding. The PC-G805 increased the RAM to 32KB and appeared in 1993.

Sharp PC-E500/E500S series (1989-2001)

Following the E200-series came the PC-E500 in 1989. While it packed another 8-bit Z80-compatible CMOS CPU, the E500 featured a new higher-resolution 40-column four-line/240x32-pixel display, which also had the capacity to now draw graphs. The new lower-power CPU could also delivered up to 70 hours' run-time from four smaller 'AAA' batteries. The design was so good, Sharp didn't update it until 1995, delivering the PC-E500S with only minor modifications including clam-shell cover, higher-contrast display and a slightly larger footprint with bigger keys.

Sharp PC-G850 series (2001-2011)

The last hurrah for the Pocket Computer came in 2001 in the form of the excellent PC-G850 series. The previous 40-character

by 4-row display was now replaced by a genuine dot-matrix 24-column six-line/144x48-pixel LCD panel, while new reduced power requirements saw the four 'AA' batteries of the G8xx series replaced again by four 'AAA' cells. The G850 series was still powered by a Z80-compatible 8-bit CMOS processor, but now included 32KB of RAM, a text-code editor, scientific calculator, plus the ability to program in BASIC, Assembler and C, as well as direct-programming of PIC microcontrollers. The PC-G850 was followed by the PC-G850V and finally, the PC-G850VS in 2001, offering an improved-contrast display.

How and why did they survive so long?

One of the reasons why the pocket computer not only survived but thrived in Japan was that it was actually the ideal teaching computer – and that's how it was used. It seems almost every Japanese technical college student had one and frankly, what a brilliant idea it was. While Australian students were largely stuck with PCs that couldn't travel or scientific calculators you couldn't code, Japanese students had a tough-as-teak portable computer that was not only still relatively affordable, but could be used to teach mathematics, electronics and computing all in the one device.

The Input/Output Interface

How did it teach electronics? It's well-known the Sharp/Tandy pocket computer gave you BASIC coding with the original PC-1211, but less well-known is that these devices were the original 'Arduino' before Arduino was a word – all thanks to its universal input/output (I/O) interface.

Like almost all 8-bit computers of the 1970s, the original Sharp pocket computers featured an I/O interface to which you could connect up a tape recorder to save code, or a printer to print out data.

However, that interface survived right through the pocket-computer era and, in later models, could even program Arduino-like PIC microcontrollers from Microchip Technology, dedicated processors with their own RAM and code



Right: Tandy switched to the Casio FX-790P as the basis for its PC-6 handheld (Public Domain).

storage designed for 'embedded' (or 'maker') applications.

But most importantly, you could use the pocket computer itself as an 'Arduino-on-steroids', writing your own code on the device to drive the I/O pins and connect them to LEDs and other components.

Sure, pocket computers weren't about to replace the PC obsession we had during the 1990s, but they didn't need to – as an educational computer, particularly for computer and electrical engineering, these things would have been brilliant. I could find no record of latter models having arrived in Australia, nor do I remember Sharp promoting them here during the 1990s/2000s, so I can only assume they never made it to our shores, except in the luggage of overseas travellers.

And that's a bit of a shame. More than a decade before Arduino became a thing, I can't help but wonder could these devices have also been educating Australian students and providing practical experience in electronics and computing, tech that is the backbone of today's Internet of Things?

The other question I ponder is this: could we have used pocket computers in Australian schools rather than scientific calculators? Aside from the issue of exams, cost most likely would've been the key. A basic laptop in 2002 cost \$3,000, whereas the Casio FX82 was closer to \$40. Unfortunately, original pricing for the PC-G850VS is impossible to find, but even if only \$150, it would likely have required a government-scale purchase to make a reality. Still, I know which I would've preferred.

Pocket computers today

The smartphone may well be the ultimate refinement of the pocket computer, but try connecting up a resistor and an LED to a smartphone, code it to flash on and off and you'll see how complex the task now is – and, by contrast, how perfectly suited the

pocket computer was as a learning tool.

While it's believed Sharp discontinued development in the early-2000s, the PC-G850VS remains on its Japanese website as an 'education' device (<https://jp.sharp/calc/product/pcg850vs/>) and although you can't buy them new at retail, used devices appear on Ebay and equivalent Japanese sell-sites, with prices starting from \$100, but going up to crazy-money of \$1,000 or more.

Back to the future

Still, this isn't the end of the story – amazingly, the Zilog Z80 is the processor that just refuses to die. After the Commodore and Texas Instruments war that saw the end of the TI-99/4A home computer in late-1983, TI went back to doing what it knew well – calculators.

In 1990, TI introduced its first 'graphing' calculator, the TI-81. Its dot-matrix display and (you guessed it) a 2MHz

Zilog Z80 processor enabled students to perform algebra and calculus equations in a hand-held device. The TI-81 was followed by the TI-83 in 1996. It still featured a Z80 processor, but now running at 6MHz. The 'TI-83+ SE' turbo-charged its clock to 15MHz, but this series was also the first to introduce user-available flash storage for loading new programs. This was further expanded in the

following 'TI-84 Plus'. In fact, these devices are now the cheapest way to buy a Z80 computer, with a good selection of used models usually selling on Ebay in Australia for under \$50.

The final Zilog Z80-powered unit was the 'TI-84 Plus C SE', which featured colour screen and appeared in 2013. The TI-84 series continues today with the 'TI-84 Plus CE-T Python', launched in 2021 and adding support for CircuitPython programming via a separate internal ARM Cortex processor. The device itself is still controlled by a more-recent Zilog 'eZ80' CPU – and still 8-bit.

Incredibly, it's now been more than 50 years since the arrival of the first 8-bit CPU, the Intel 8008, in 1972. The rapid decline in CPU prices in the mid-1970s brought on by the arrival of the Z80 and 6502 made it possible for brands to develop affordable computers.

But we must remember that Australia didn't bother waiting for Tandy, Commodore and Apple. Whether it was Jim Rowe's EDUC-8 computer of 1974, the Dick Smith VZ200/300-series or the famed Microbee, Australia was a home-computing pioneer – and we have our electrical engineers to thank.

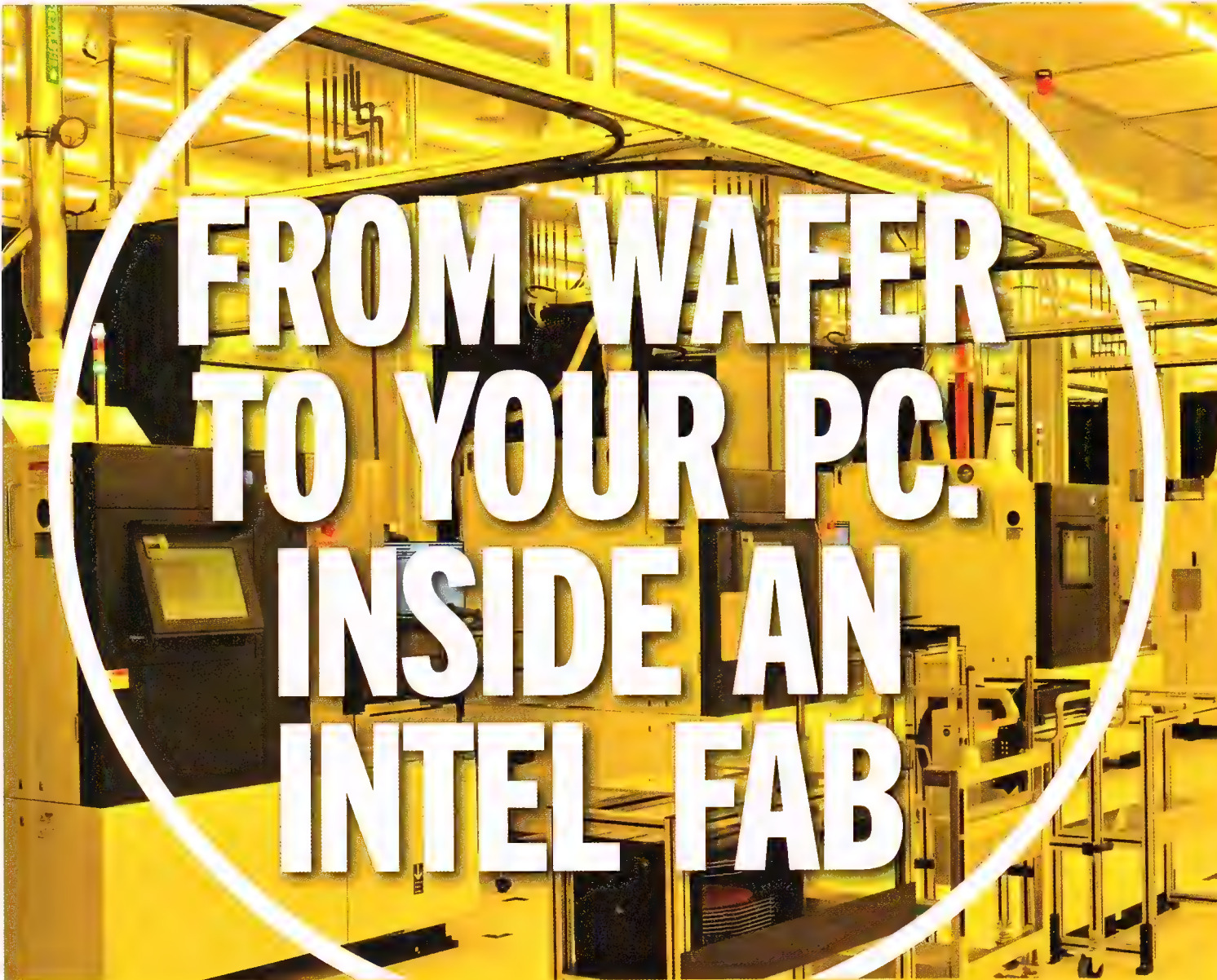
Next time...

This is the last in this series, I hope you enjoyed it. If you'd like to see a 1986-1995 follow-up series in the future, drop us a line at apcmag@futurenet.com. Meanwhile, next issue, we embark on a new adventure into the world of electronic vision. It's an epic story that begins in the farming fields of Idaho, as we re-trace 100 years of some incredible technology developments. Hope to see you then. ■

Above: The last Tandy handheld was the PC-8, otherwise known as the Sharp PC-1246 (Image credit: Jcassara86, CC BY-SA 4.0).



Above: A used Texas Instruments' TI-84 Plus gets you a Zilog Z80 CPU for around \$50 on Ebay (Image credit: Asimzb, CC BY 3.0). **Left:** Texas Instruments continues the TI-84 series today with the new Python model, launched in 2021 (Image credit: Texas Instruments).



FROM WAFER TO YOUR PC. INSIDE AN INTEL FAB

CHRIS SZEWCZYK GOES BEHIND THE CURTAIN OF SOME OF INTEL'S MOST ADVANCED MANUFACTURING FACILITIES.

The world of semiconductor manufacturing is an opaque one. Enthusiasts understand what a CPU is and what it does, but the actual steps and processes involved in their manufacture is far less understood by anyone that doesn't hold an advanced engineering degree or two. So, when Intel invited me to visit its facilities in Penang, Malaysia to learn more about chipmaking wizardry, I was more than happy to accept.

Broadly speaking, Intel's Malaysian facilities include areas that cut and sort incoming wafers followed by assembly and installation onto substrates before they take their final forms. At all stages there are tests and more tests before they're tested further. We were also invited to visit labs that analyse failed dies and chips, and even one that builds testing equipment for Intel factories all over the world. Additionally, there's a lab that tests the test equipment.

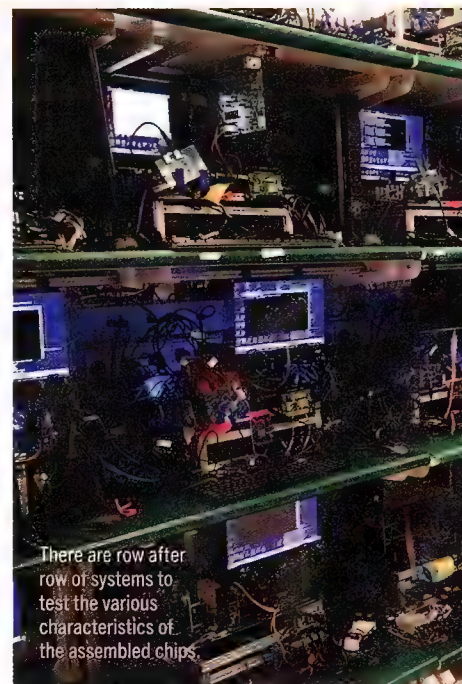
One of the Intel representatives I spoke with called it the most advanced

manufacturing on the planet and it's hard to argue with that. Of course, you have stuff like quantum computers or fusion reactors at the cutting edge of scientific research, but they're not at the manufacturing stage.

And anyway, all of the R&D that goes into those things needs everything from laptops to supercomputers. And that means they need chips like those that pass through facilities like the ones in Malaysia. It's important work. Without chips and transistors, everything effectively grinds to a halt.

On a personal level, I find semiconductor manufacturing absolutely fascinating. The technology, science, research and development, engineering, and frankly, wizardry of it all can seem otherworldly. I am thankful for the chance to take a peek behind the curtain and gain an understanding of what goes into these magical little bits of technology.

The tour was made up of two parts. Well, three really. The first day of the tour



There are row after row of systems to test the various characteristics of the assembled chips.



consisted of a visit to Intel's Penang Assembly and Test facility (PGAT). The name gives away its purpose. This facility takes the incoming dies and mounts them onto their PCB substrates, before TIM is applied, and heat spreaders are added. The second day involved a trip to the Malaysian mainland for a visit to Kulim based die sort and die pre facilities.

For this article, I mostly split it up according to the manufacturing stage rather than chronologically. We weren't allowed to record anything or even carry a notebook in many places, so I hope my brain cache didn't fail.

INTEL LAYS OUTS AN AGGRESSIVE ROADMAP

As part of the tour, Intel laid out its vision and plans for the next few years. It refers to its plan as IDM 2.0 (Integrated Device Manufacturer). Having dropped the ball with its overly ambitious 10nm rollout followed by the pandemic fallout, the company has certainly needed a reset.

That means building sustainable, resilient supply chains and adopting manufacturing processes that scale effectively. Then there's the use of external foundries where appropriate and the introduction of Intel Foundry Services, where Intel's manufacturing expertise can be accessed by fabless customers.

A lot of that sounds a bit PR friendly but it's clear Intel has been executing this strategy for some time. Just look at how much money it's investing into various sites around the world, wooing clients, and striving to catch up to TSMC for manufacturing leadership.

Intel's aggressive goal is to achieve five nodes in four years.

Intel 7 is in full production already, while Intel 4 (used by Meteor Lake) is ramping up. Intel 3 is then an evolution of Intel 4, while Intel 20A and 18A are planned to be ready for manufacturing in 2024. That means we're getting close to the angstrom era, with sub 1nm (10A) manufacturing already being developed.

Oh, have you heard of AI? It's a thing apparently. Intel is betting on an open ecosystem and eventually sees AI becoming democratised and a ubiquitous part of not just cloud and LLM applications, but a part of everyday computing.

WAFERS GO UNDER THE KNIFE, AND SORTING OPERATIONS

Intel's Kulim facilities are located on the Malaysian mainland. This is where incoming wafers are processed, prepared and sorted before being sent off to assembly facilities around the world.

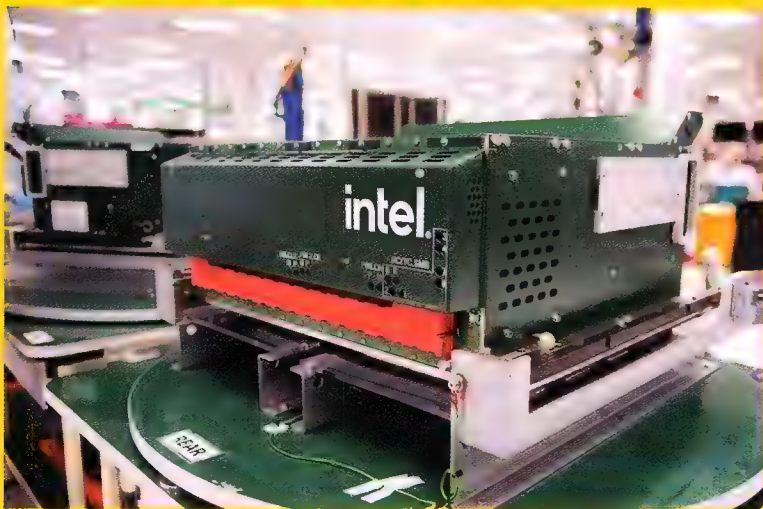
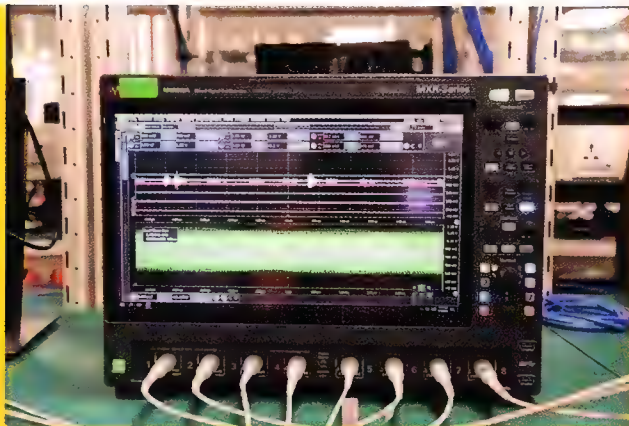
The Kulim plant houses a system integration and manufacturing facility. It produces testing equipment and boards for Intel fabs, factories and labs worldwide. In essence, it's a facility for building and testing test equipment.

Intel's Malaysia facilities don't include a wafer fabrication plant. The wafers are shipped to Malaysia from any of the various

This machine tests PCIe 5.0 signal integrity.

Chips are tested with consumer operating systems to check they work properly under real workloads.





Top: Voltage testing is key to determining the functionality and performance of a chip.

Top right: Sophisticated and programmable water cooling systems are used to check the thermal characteristics of chips.

Above: Much of Intel's test equipment is manufactured in house.

fabs in the USA, Ireland, or Israel.

The wafers arrive in what Intel calls the KMDS DP, or Kulim Die Sort Die Prep plant. Typical 300mm wafers are progressively cut up via a process that includes laser scribing and mechanical cutting with diamond saw blades. It sounds fairly rudimentary but it's done with absolute precision. From there, the dies are moved onto sorting operations.

Once the wafers have been cut, the dies run through tests to determine what they will end up as. To use 13th Gen Rocket Lake chips as an example, the dies need to be tested and sorted to determine whether a particular die will end up as an i9 13900, 13900K or 13900KS.

The machines that do this sorting are amazing pieces of tech by themselves. There are row after row of them. Each weighs 1000 pounds. They are a bit like hovercraft, sitting on a cushion of

air for easy movement, should a unit require maintenance. We saw one being easily pushed around with a lifter mechanism, handled by just two people.

Each die is tested by connecting it to a probe card which contains thousands of needles thinner than a human hair. Once the chips are tested, then they move onto the PGAT assembly and test factory before they take the form of the chips we know and love.

BEHIND EVERY GOOD DIE IS A GOOD SUBSTRATE

In order to access this part of the Intel Penang Assembly and Test facility (PGAT), we were required to suit up in order to conform to clean room requirements. One of these vast clean rooms houses machinery that installs incoming dies onto their substrates.

It used to be that monolithic dies could be slapped onto a substrate and that was pretty much that, but with modern chiplet designs, (or tiles in Intel parlance) the assembly process is much more complicated. Start adding 3D stacking and Intel's Foveros technology, and assembly is an obviously critical part of the chip making process.

Just take a look at an Intel Ponte Vecchio compute GPU [\[1\]](#). It's perhaps the most ambitious processor in Intel's history. It packs in 47(!) tiles, five different process nodes and over 100

billion transistors onto one substrate.

When we talk about chip tech, we often refer to lithography and nodes, but chip packaging deserves just as much spotlighting, and that goes for AMD too with its Zen chiplet designs. Taking all of these tiles, with a mix of nodes and even manufacturers, getting them to talk to each other while maintaining signal integrity, at scale and with all of its functionality intact is a massive achievement. Well done Intel.

Once the chips are attached to their substrates, they have an epoxy material applied. This ensures the dies are 100% level, ensuring physical stresses are uniformly distributed across the dies. The chips are then sent off to settle for a while before the thermal interface material or solder is attached, and the heat spreader is installed (where applicable). They are then sent off for barrages of tests.

The PGAT facility houses design and development labs, a failure analysis lab and areas for testing chips in various stages of production, including tests that incorporate typical end user workloads.

NOW, LET'S SEE WHAT YOU LITTLE BLIGHTERS CAN DO.

The assembled chips are sent off to a part of the PGAT factory to



confirm whether assembly was successful. First up is a burn in test. Machines punish the chips with high temperatures of over 100°C and voltages up to the limits of the specification.

Following the burn-in test, a series of electrical tests are performed, this involves tests of the functionality of the chip and a check to ensure the traces and substrate are functioning as they should.

If that's successful, the chips move onto real world testing. Chips are mounted onto testing platforms that begin to resemble something like the PC we know and love. These in-house-built test platforms use different operating systems and software to mimic real world use. I saw 3DMark looping on a series of systems. I half expected to see an engineer playing Baldur's Gate 3. For research and testing purposes, of course!

FAILURE ANALYSIS. YEP, THERE'S A SONAR TEST.

As much as Intel would like it to be the case, not every chip comes out of the factory in perfect working order. That doesn't mean the failed ones are completely dead though. Maybe testing reveals an anomaly, a functionality failure, or something that requires analysis. In that case, they are sent over to Intel's failure analysis lab.

This lab is a bit smaller than the vast floor spaces common to the rest of the facility, but it's no less interesting. Intel has all kinds of advanced equipment to test for failures. There's the obvious visual inspections via microscopes or electrical tests with oscilloscopes, but there's more advanced thermal imaging equipment too.

One of the most interesting things of the whole tour was seeing a kind of ultrasonic sonar wave testing machine that

involves sitting the chip in water. Now is a good time to mention that we weren't allowed to take pictures inside any of these facilities, and in fact were not allowed to carry phones, watches, or wallets.

And I'm kicking myself for not seeing this first hand, but apparently there was at least one Battlemage GPU out in the open in this lab. This is a next generation Intel GPU, and it's a good sign that these are in the production stage and being analyzed. It would indicate Intel's next gen graphics card range is absolutely on target for a 2024 launch. Well, so long as the failures aren't too grand in scale.

TESTING EQUIPMENT, AND THE TESTING OF THE TEST EQUIPMENT THAT DOES THE TESTING

Factories like this need a lot of custom equipment. The machines used for manufacturing and production are finely calibrated pieces of precision equipment. It's not the kind of stuff you can order from eBay.

Intel has a division it calls System Integration and Manufacturing Services (SIMS). Its purpose is to make equipment for testing and validating the chips. All of the post assembly test rigs are made in house. There's even a section of the plant that tests the test equipment. In case you didn't know, there's a lot of testing of everything!

A couple of examples of Intel's bespoke test equipment include machines that perform burn in stress testing while another performs backend testing. The picture below shows a custom machine used to test power related components. ²

SOME RANDOM OBSERVATIONS AND CLOSING THOUGHTS

As I began writing this up, I wished I'd been allowed to carry a notebook. Not so I could pass

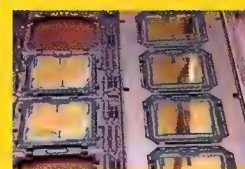
trade secrets to AMD, but just so I could remember the massive amounts of information we were given!

Overall, the trip was amazing. As a reviewer, this kind of insight into the manufacturing process was invaluable, personally and professionally. I like to think I understand CPUs pretty well, but seeing the sheer scale of Intel's operation was a real eye opener.

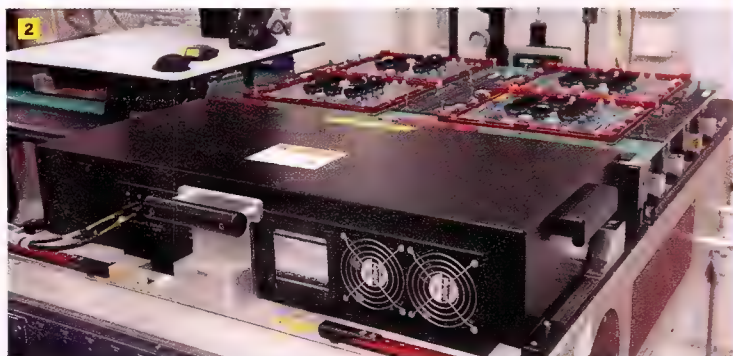
One of many highlights was seeing semi-autonomous robots scooting around the die sorting and prep area. They put out constant appealing musical chimes. They take various dies or wafers from one area of the factory to another, always with a smile!

Arthur C. Clarke is remembered for his three 'laws'. The third of which states: "Any sufficiently advanced technology is indistinguishable from magic".

Those inside Intel would say it's all advanced engineering, and they're right, honestly. But after seeing what these folks do first hand, there has to be a little bit of magic involved, surely. If not that, then I'll go with aliens.



Above: Ponte Vecchio compute processors before and after having epoxy applied. Below: Testing the test equipment. Bottom: A worker assembles a bespoke test system PCB.



CLOUD COMPUTING: DRIVING F1 FORWARD?

Amazon's cloud computing resources helped F1 overhaul the design of the cars in 2022. **Barry Collins** examines whether it really made the sport a better spectacle.



How do you make F1 more exciting? Danny Baker had the brilliant idea of making drivers do the first lap on foot, but that's unlikely to go down well with Lewis Hamilton and co. Instead, ahead of the 2022 season, the F1 authorities decided to use the power of cloud computing to make races more competitive.

Nobody wants to spend two hours of their Sunday afternoon watching cars file round a track in a procession – least of all the millions of fans drawn in by the deftly edited highlights shown in Netflix's *Drive to Survive*. So, Formula One decided to change the rules, to enforce modifications to the design of the cars that would make it easier to overtake, inducing more of those moments that make Martin Brundle's voice shoot up an octave.

F1's engineers and experts had a good idea about what modifications would result in more overtaking, but they needed the evidence to prove it. Testing is wildly expensive and terrible for the environment; wind tunnels are limited in size and scope, especially when you're measuring the impact on overtaking, a test that necessarily requires two cars. Instead, F1 turned to its partners at cloud computing giant AWS to see if software simulations could provide the answers.

I met with Dr Neil Ashton, principal computational fluid dynamics architect at AWS, and Formula 1 pit lane legend and former Ferrari race engineer, Rob Smedley – now an F1 consultant working alongside AWS – to find out how F1 leaned on cloud computing to design the 2022 car, and whether it worked.

Let them race

F1 often finds itself in a dilemma. The safety of the sport has improved vastly since the days when drivers such as Jackie Stewart had a 50/50 chance of dying over the course of their career. At the same time, fans aren't shy about reaching for the remote when races are boring because there's little wheel-to-wheel action. "Trying to get the potential of an overtake, or the actual overtake itself... creates the excitement that we all want," said Neil Ashton. "And if we go back maybe a couple of years to the prior generation of racing cars, I think it was definitely the case that there was a lack of overtaking, and that was certainly reflected by the fans."

F1 teams design their own cars – it's part of what gives the well-funded teams such as Red Bull a competitive advantage over teams more often at the back of the grid. But teams must design those cars within the very tight confines of the F1 regulations, which stipulate how big certain parts must be, or put constraints on the design of different components. It was these regulations that the F1 management wanted to overhaul ahead of the 2022 season to encourage more overtaking.

Data has often been described as the new oil, and even in F1 the data is now much more valuable than the black stuff. When Rob Smedley joined F1 as a race engineer in the mid-1990s "we still had abacuses", he joked.

"When I first came in, there were probably 20 sensors on the car," said Smedley. "Fast-forward not many years after – in fact, about five years – and there's probably something like 100 sensors on the car and like 1,000 or 1,500 data channels.

"If you look at today's cars, in test mode, they might have 500 sensors on the car, just to keep extracting more and more data."

Smedley said his generation of engineers pushed the use of data to "drive better decisions" for two reasons: "one, to design fundamentally faster racing cars and then, two, to optimise those racing cars for any given track or condition.

"We started to use much heavier deployment of data analytics, we were very early adopters of neural networks and subsequently machine learning. Given the complexity and how wide the problems are, it's just kind of gone on from there," he said.

So, with no shortage of data to fall back on, F1 bosses turned to the cloud to help them rewrite the rulebook.

"We started to use data analytics, we were very early adopters of neural networks and subsequently machine learning"

Testing times

When it comes to testing F1 cars there are several options, but none of them is cheap. Ashton said the "old-school way of doing it" is the physical test, where you drive a car around a circuit lots of times to collect data. "Formula 1 recognised that, one, that was costing a lot of money and, two, it's not really environmentally friendly to be doing that sort of testing. So, physical testing from a Formula 1 point of view has long been reduced."

Then there are wind tunnels, dedicated facilities where big fans blow wind over the cars to test the aerodynamics of new designs. Ashton said NASA had one facility where you could fit a whole aircraft inside the wind tunnel, but "it requires the power of a small city". Although the F1 tunnels aren't that power-hungry, they're still expensive to construct and limited in space, which isn't ideal when you're trying to measure the impact on overtaking. "In this particular scenario, it was two cars following each other, which is definitely hard to fit in a wind tunnel in the first place," said Ashton.

What's more, when cars are out on the track, they're not racing in a straight line, they're barrelling round corners and chicanes, which are "very difficult to replicate in a tunnel that is usually a rectangle".

So, wind tunnels are expensive and can't measure half the things you want to check when evaluating the impact of





“Essentially, there’s a linear relationship between the accuracy of the simulation and the compute power required”

new car designs. It would have to be simulated in software, but why go for the cloud instead of a dedicated supercomputer? “They [Formula 1] did have access to computing power through an on-premise, more classical ‘supercomputer’, but that had a fixed capacity, which meant that simulations were taking about 60 hours,” said Ashton.

With a supercomputer taking up to three days to run a simulation, and only having the capacity to run one simulation at a time, “it really did limit their capacity to go through many, many different designs,” said Ashton. “Whereas the whole premise of cloud computing is you get access to this virtually unlimited capacity, where the limitation is really on the individual to produce the ideas rather than the compute.”

Running the new car designs through a simulation on AWS’s cloud infrastructure instead of the supercomputer reduced the time of each run from 60 hours down to 12. And the cloud could handle multiple runs simultaneously. “That’s the difference between getting something done on the same day versus two or three days,” said Ashton. “You go into the office, you run something, you get it back by the end of the day.”

The F1 engineering team originally planned to run 20-30 simulations a

week, but was able to boost that to 80-90 tests with AWS’s cloud infrastructure. With a limited window in which to rewrite the rulebook, so that teams had time to apply the design changes and run tests on their own cars, the cloud made a much bigger set of changes possible.

As pure as the wind?

Running simulations on AWS might be cheaper and faster than using a wind tunnel, but is it as accurate? Neil Ashton claims it’s close. “It depends very much on the specific simulation that’s being done,” he said. “It can be within a few per cent, so 1 or 2% difference. But it could be worse than that, or better than that, depending on the specific technique that’s used.”

However, the more computing power that’s thrown at the problem, the better the results. “Essentially, there’s a linear relationship between the accuracy of the simulation and the compute power required,” Ashton added. “That’s why so many companies are moving to the cloud, because they see that if they want to get their simulations to be more accurate, they need more compute. If

you want to close that gap from 2% to 1% to 0.5%, it’s increasingly going to be about more compute. That’s the direction of travel across many different industries.”

Aside from adding multiple cars to the scenarios, there are other things you can do in software simulations that you can’t easily replicate in wind tunnels. “The additional advantage of simulation is the fact that you can start to include more environmental effects,” said Ashton. “You could start to explore the effects of cross winds, the effect of the car being in front of you, as we said, the effects of temperature, the effects of rain.”

Simulations also let testers model the fluid and structural motion of the car together, “so you can really start to get into the physics,” said Ashton.

Finally, once all the simulations are run and results are collected, “that mathematical model can essentially go inside your racing game”. That is, the car simulators F1 drivers train with. “When they give that test driver the steering wheel, that person will have pretty close to a feel of what the car would be like, so that when a team says we have a new part that we’d like to test, they will actually test it in the simulator first to see if it gives an advantage. If it gives an advantage in the simulator, then they may go and physically build it and send it to the track.”



ABOVE Real race conditions can't be replicated in a wind tunnel. **LEFT** The Mercedes team's form tanked after the new rules were introduced.



season's final standings might lead you to conclude otherwise. Max Verstappen strolled to victory in the driver's championship, finishing almost 150 points clear of his nearest rival by winning 15 of the 22 races. The constructors' championship was equally one-stroke, with Verstappen's Red Bull team finishing 200 points clear of Ferrari.

The 2022 season was notable for the collapse in form of Mercedes. The 2021 championship was a nailbiter, settled in the final race of the season, when Verstappen overtook Mercedes' Lewis Hamilton on the final lap, after a hugely controversial decision by the stewards to let only a small number of cars unlap themselves before the race was restarted. In 2022, however, Hamilton didn't win a single race and the team won only one.

Mercedes suffered badly from the rule changes. Early in the season, the completely redesigned car suffered terribly from "porpoising", a bouncing sensation that made the car difficult – even painful – to drive. Several teams suffered a similar effect, but the Mercedes car suffered the most, even porpoising along the high-speed straights.

But that doesn't mean the rule

Did the new rules work?

Whether a F1 car can overtake the car in front of it (assuming there's enough space to pass) is largely dependent on downforce. Cars lose up to half of their downforce when racing closely behind a competitor, because of the turbulent air generated by the car in front, causing the chasing car to lose grip on the track.

The goal of the 2022 rule changes was to create a car with a much smaller "wake", reducing the turbulence experienced by chasing drivers coming through dirty air. To that end, wheels

were fitted with wake control devices; front wings were simplified to divert airflow off the front wheels; and the rear wing was redesigned to draw in air from the sides and lift the expelled air above the car following behind. Wheel sizes were boosted from 13in to 18in and fitted with low-profile tyres. All of this was simulated over the course of six months, generating 550 million individual data points, before the rules were finalised and teams could get on with designing their own cars.

Did it work? Did F1 really become a better sport to watch? A look at the



changes were a failure. Speaking after the fourth race of the 2022 season, several drivers said the rules had achieved the aim of making it easier to overtake. "It's 100% better," McLaren driver Lando Norris told the BBC. "It's what they intended to do and the reasons for the changes are working. I think you have been seeing better races this year than for many years." Verstappen and AlphaTauri's Pierre Gasly both agreed it had made it easier to battle the car in front.

Mercedes' woes might have initially been pinned on the rule changes, but there were other considerable problems with that car – problems that haven't really been resolved more than a year later. Red Bull has won the first 12 races of the 2023 season, at the time of writing, with Mercedes a distant second. The rules were tweaked again at the start of the 2023 season, and they will continue to be for years to come, as F1 looks to get the formula

ABOVE The rule changes were intended to make overtaking easier.

"If you could do more and more compute, you could design the cars more efficiently. That would create even more exciting cars"

right. Hamilton's teammate, George Russell, remarked recently: "The sport took a really good turn for the better when these new cars were introduced [in 2022], but we need to take it to the next step now."

Neil Ashton thinks that's possible with ever-more cloud compute power coming online with each passing year. "If you could do more and more compute, you could design the cars more efficiently," he said. "That would create even more exciting cars, that would create even more exciting racing. I think we're in an inflection point now where it could really do something great for the sport."

Behind the scenes at Silverstone

When Formula 1 comes to town, a whole industry travels with it. Huge trucks arrive at each location, turning Transformers-style into temporary HQs for each team. This is the paddock, where celebrities hang out and Sky's Ted Kravitz attempts to grab the latest gossip.

Tucked discreetly behind the paddock, attracting no attention at all, is F1's Event Technical Centre (ETC), a suite of temporary rooms packed with screens, PCs and serious-looking people dressed in black. In terms of data, this is the ground zero of each race. Every single crackled conversation from the drivers to their engineers, every byte of information tracked by the dozens of sensors on each car, each of the multiple 4K video streams that eventually appear on our screens.

For while the coverage you see on TV is topped and tailed by the hundreds of broadcasters who beam races around the world, they rely on a single source: F1 itself. It has total control of the broadcasts, as if it was a TV production company as well as the organiser of the event. F1 also fully controls the technical services, from the timing that decides who wins and who loses to the bottomless pit of telemetry (rev counts, the steering angle, the G-forces) that viewers eventually see on their screens.

This process is managed by a comparatively small team that's more akin to an SMB with a few hundred employees, rather than the global megabrand we think of when we imagine Formula 1. "We're not a massive organisation," said Pete Samara, director of innovation and digital technology at Formula 1, speaking on the Friday (practice day) before this year's Silverstone race. "We're effectively an SME, and efficiency is really important."

At its most basic that means buying hardware that will keep working ("that we don't need to switch on and off") and a system that allows staff to order whatever

they need to their job. "We've got engineers, editors, broadcast graphics operators, CAD designers that are 3D-forming this building. So all types of user profiles."

For the past few years, F1 has chosen Lenovo as its hardware partner, and that partnership extends to its data centre. Or, strictly speaking, two data centres. We've already mentioned the mobile control centre that pops up at each race, but that's merely a satellite compared to F1's Media and Technology Centre in Biggin Hill.

Processing all the data captured at each event – that's around 500TB of media in the course of a 90-minute race – needs far more compute power than the modest hardware contained in the ETC, so it must be instantly beamed back to F1's newly expanded base in Biggin Hill. That data is then processed in real-time and transmitted to each broadcaster around the world.

F1 also has big plans to enhance the quality of the data it provides to broadcasters in the coming seasons. Rob Smedley said he'd spent some time with the football Premier League broadcasters, watching how they cover live matches. "You'll have your data scientists in the background saying 'right, here are some really interesting stats', and then you'll get the pundits, who are actually engaging directly off-camera with the data science team... and they feed that directly to the audience."

"We need to get to that [in F1]," said Smedley. "There's technology we're trying to build with AWS at the minute that will eventually get us to that. It will be more virtual, it will be more AI driven, because you've got a hundred different broadcasters with a hundred different commentators, all maybe at that point telling a hundred disparate stories. So, in order to get in sync, then we've got to use the data, but we've also got to use technology." ■



ABOVE The tech behind the scenes processes around 500TB of data at each F1 race.

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THE POWER

Look beyond the mainstream options and you'll find web browsers that offer many more features.

Barry Collins examines three great alternatives.



If you fired up Google Chrome today and the version that first launched in 2008, you'd struggle to tell them apart.

The address bar runs along the top, there's a row of bookmarks underneath, a few basic buttons to the left, tabs at the top, and that's yer lot. Has the way we use the web really not changed in 15 years? There are alternative browser makers out there who would strongly disagree.

Google pioneered the fuss-free, feature-stripped browser in 2008 and the rest of its mainstream rivals followed. But there's a new undercurrent of "power browsers" designed to satisfy users who want more from their web browser. Browsers with built-in email clients and feed readers, browsers that separate home and work life, browsers that don't endlessly distract you from the task at hand with notifications and alerts.

The web browser is the most used

piece of software on most computers. Shouldn't it be better?

The mood for change

Jon von Tetzchner has form when it comes to creating alternative browsers. In the early 1990s, he co-founded Opera, a browser that regularly won fulsome reviews in APC for the breadth and originality of its feature set. In 2015, von Tetzchner did it again, founding the Vivaldi browser and continuing the same ethos of a feature-rich, privacy-friendly browser.

Von Tetzchner thinks that companies such as Google and Microsoft don't have to work too hard to make their browsers stand out because they have the inherent advantage of being able to bundle browsers with their operating systems. "For browser makers, the larger ones in particular, the point has always been 'we don't need to differentiate, we just need to make it easy to switch. We have a distribution advantage... We want to make it simple to change.'"



There are other reasons why the big players don't pack lots of extras into their browsers. "If you don't have a lot of features, there's less that can go wrong," he said. "You can just focus on simplification and then you can say, okay, if you want something more advanced than this, you have to go and get extensions."

But in recent years, we've seen Microsoft begin to add features into Edge, and von Tetzchner believes that's a consequence of consumers growing frustrated with the limitations of the browsers. "Microsoft has been trying to find a reason for people to use their browser, so they've been adding a little bit. Even Google has been adding features. I guess they don't want to get into a situation where they don't have any of the features and people actually start to move somewhere else."

Yet, even if Edge – with its new-found focus on AI assistance – and Chrome are beginning to pad out a little, they don't offer anywhere near

BROWSERS



the number of features and customisations you'll find in Vivaldi or emerging rivals such as Arc and Sidekick (you'll find full profiles of all three later in this feature). Yet all three of the power browser rivals are based on the same Chromium engine as the big two browsers.

And although the power browser makers must still be wary of feature bloat and its impact upon system performance, von Tetzchner believes adding features these days is less risky than it was in the past. "The speed of the network and the speed of the computer is less of an issue now than it used to be," he said. "Most computers are fairly advanced and obviously now most of the browsers are using the same core, so there will only be limited difference in speed, unless you do something different."

One size doesn't fit all

For Dmitry Pushkarev, founder of the Sidekick browser, it's less about adding features to Chromium and more

about taking things away. Pushkarev suffers from ADHD and he wanted to design a browser that would help him work without the constant distractions. "Browsers have never been designed with work in mind," he told APC. "In fact, they've been designed specifically to distract you, or send you towards the search engines. The way they make money today is basically they're being paid a fraction of search revenue. So, in fact, their incentive is very much to impair work and impair focus. And even though for most people it's just a minor nuisance, for myself and for maybe another 50 million people in the world, that's actually quite a bit of pain, because you really cannot get anything done."

Sidekick has a host of features designed to minimise distractions and keep the user focused on the task in hand, which Pushkarev

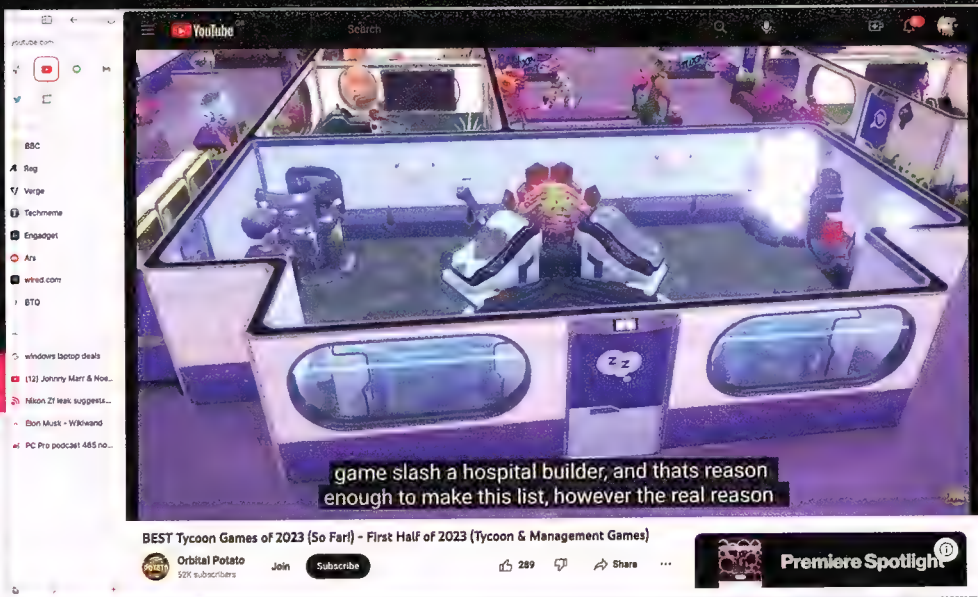
"Browsers have never been designed with work in mind. In fact, they've been designed specifically to distract you"

claims benefits anyone working in a browser, not just people with ADHD. "The social cost of this pretty unbelievable – nearly a billion people work in a tool not designed for work," he said.

"You don't have any other industry like that, except for online work. Every other profession – take firefighters, restaurant chefs – they all have their own tools. We have a billion people who work online in tools designed to steal your attention. This is one of the big opportunities to make society better."

Want to see what an alternative browser could do for you? Our in-depth profiles of Arc, Sidekick and Vivaldi on the following pages might just convince you to switch away from your current browser and try something new.

ARC



Arc is without doubt the fashionable browser of the moment, the browser that kids wielding MacBooks in Manhattan juice bars are using. I say MacBooks, because right now the browser is Mac only, although there are plans to release a Windows version later this year.

Arc isn't just the browser to be seen with, however. It brings fresh ideas to the table, including power features that APC readers may well appreciate.

Arc is created by The Browser Company, a startup co-founded by Josh Miller and Hursh Agrawal, both former Facebook employees. However, it's another tech giant the pair have clearly got in their sights. Visit the Arc homepage and front and centre is a pull quote from The Verge's review of the browser, proclaiming: "Arc is the Chrome replacement I've been waiting for."

The company's mission statement on LinkedIn reinforces the message. "The world has changed in the past 15 years, but our web browsers look and behave pretty much the same. We think it's time to push the web browser forward again, which is why we built Arc – a browser that's not just faster, but also more personal,

focused, creative... and maybe even more fun."

The one modern browsing problem that The Browser Company has identified and is tackling head on is dozens of abandoned, disorganised tabs. The Arc browser is divided into Spaces, where tabs are organised by different themes or projects (see *opposite*), and ordinary tabs that are left open for extended periods of time are automatically closed to reduce clutter.

"It's similar to your physical home – you have different rooms for different things, with different feels and different things in them," said co-founder Josh Miller in an interview with VentureBeat in 2021. "We want to give people that same level of control when it comes to designing their home on the internet. If my wife and I are trying to figure out our son's immunisation requirements, that space should feel different and focus me differently than if I'm going down a rabbit hole on YouTube."

Miller claims that dividing the browser into Spaces helps to prevent attention drift. "I stay more focused when I don't have to context switch all the time," he said.

ABOVE Arc packs a number of power features designed for enthusiasts.

"I have all these apps that I use, and I'm constantly flying around between them. It's much more distracting than people realise."

Arc looks very different to the big-name browsers, too. Most of the action takes place in the left-hand pane, leaving the right-hand side of the screen devoted to the web content. The address bar is squished into the top-left corner, just above a rather contained area for bookmarks. That said, a recent update allows users to "unhide" the toolbar, which puts the address bar back in its traditional place at the top of the browser window. Arc also makes it very easy to tile tabs – you just drag them into position in the main browser window, much like split-screening in Windows.

Bookmarks work differently in Arc than they do in other browsers. When you click on a bookmark, its content fills the web pane to the right, but it doesn't create its own browser tab – again helping to keep things tidy. Certain sites and services also offer bookmark previews. For instance, you can hover your mouse over a Google Calendar bookmark and get a small pop-up showing the remaining appointments in your diary for the rest of the day.

Then there are the more creative

It's similar to your physical home – you have different rooms for different things, with different feels and different things in them

Arc facts

Supported OSes: Mac, iOS (companion app), Windows coming in 2023

Browser engine: Chromium

Support for browser extensions: Yes (Chromium)

Founded: 2022

features in Arc, the ones that add the “fun” mentioned in the mission statement. Easels, for example, which give you a freeform web canvas on to which you can place text, images, links and shapes, or draw freehand.

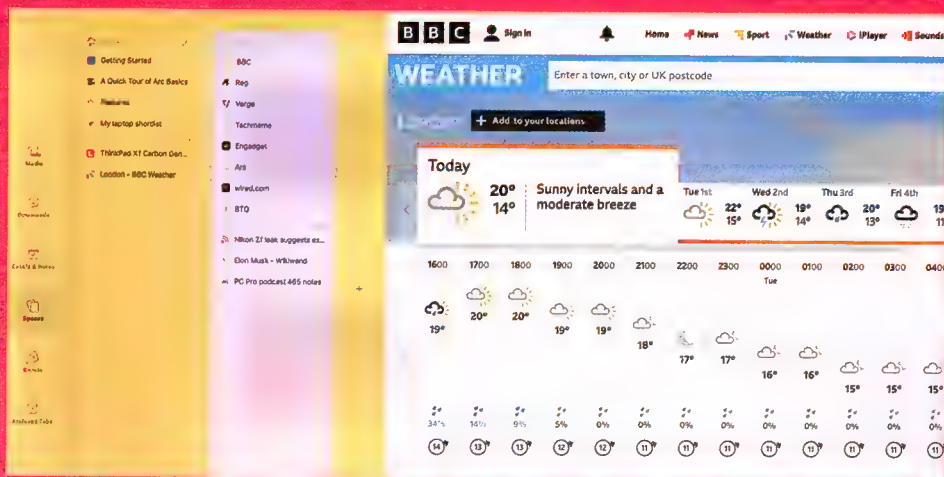
More recently, Arc added Boosts – an odd name for a feature that allows you to customise the design of certain websites every time you visit. Think the font on a particular site is too small? You can enlarge it with a Boost. Don’t like the new Twitter “X” logo? Zap it and never see it again (that noise you can hear is a capricious billionaire imploding). Boosts can be shared with other Arc users, too. One of the Boosts we found in the online Gallery removes the annoying Shorts from the YouTube homepage, for example.

Arc’s biggest current weakness is that it doesn’t really have a mobile version. There is an iOS “companion app” that effectively allows you to open pinned tabs in your Arc Spaces, but it’s clunky and not a great experience. Bookmarks are missing, there’s no easy way to enter passwords on sites, and if you’re using Arc on iPad it appears at iPhone size and has to be manually enlarged, which always looks awful.

The patchy mobile browser and current lack of a Windows version highlights one of the big problems for these startup browsers: getting stuff done without hundreds of dedicated developers isn’t always easy.

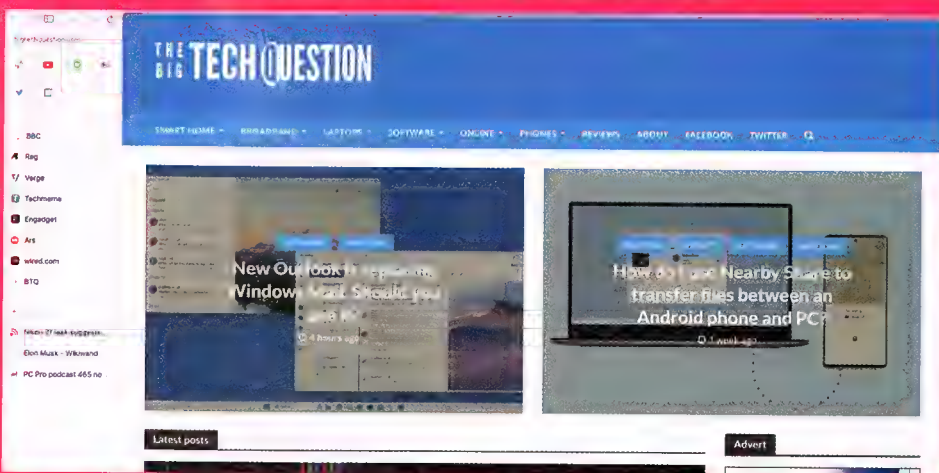
Spaces

Spaces – similar to Vivid’s Workspaces (see p32) – help you organise browser tabs by activity. You might have a Space for home and another for work, for example, or different Spaces for different work projects. Each Space has its own unique set of pinned and regular tabs. Only favourites – the icons under the address bar in the top left of the window – remain in place, no matter which Space you open.



Tab handling

tabs are handled very differently in Arc. For starters, they live in the left-hand pane, not across the top of the window. Pinned tabs sit above the divider line, and are intended for those sites/services you’re in and out of constantly, such as a web CMS. Regular tabs sit below the line, and are automatically expunged after a set time (the default is 12 hours) to prevent the Space becoming cluttered with open tabs.



Easels

Easels are a blank canvas, allowing you to plonk images/screenshots of a web page, annotate them with text, draw arrows and other shapes. They’re a great way to pull together ideas for a project. Easels can be shared and are viewable in any browser, but you’ll need Arc to edit them. Arc also has a more conventional Notes facility.



Little Arc

This delightfully clever feature helps prevent your browser drowning under the weight of open tabs. Say you’re reading an article and there’s a link to a related item: you can right-click on it and open it in Little Arc, a small window overlaid on your current window. You can quickly check the info on the link and pick up where you left off on the original page.



SIDEKICK



Sidekick facts

Supported OSes: Windows, Mac, Linux

Browser engine: Chromium

Support for browser extensions: Yes (Chromium)

Founded: 2021

Sidekick is a browser with a purpose: it's designed to provide a distraction-free environment for work. Specifically, it's designed for people with ADHD, such as the browser's inventor Dmitry Pushkarev, but that doesn't mean it should be pigeonholed as a browser for people with special needs.

"Whatever works for people with ADHD would also work for pretty much anyone else," said Pushkarev, who has a PhD in theoretical physics from Stanford and who co-founded Molecule, a genome-decoding tech that was eventually acquired by Amazon.

Sidekick aims to keep users focused on the job in several ways. First, it attempts to save you from having to flick between different apps on the desktop by creating a sidebar of web apps that runs down the left of the browser screen. In the paid-for Pro version of the browser, those apps can be used in split-screen mode, allowing you to copy information from a Slack

conversation and paste it into a Google Calendar appointment, say, without leaving the browser window.

At the bottom of the browser screen lurks a bell icon that allows you to switch off notifications for a set period of time or indefinitely, helping you to avoid becoming distracted by that new message indicator in your Gmail app. Likewise, ads, trackers and other pop-up notifications are blocked by default to keep the browser clean and nimble. "It actually blocks all requests that are not important to render the page," said Pushkarev. "For example, if you open CNN, you will actually see that most of the requests are being blocked because those requests to trackers and ad networks are basically sending the data to third parties. We block all these because you actually don't need to run them, and as a result we use a lot less memory and load the page faster.

"It doesn't seem like that big of a deal, you know, an extra 100 milliseconds here and there," Pushkarev added. "But for people with ADHD, it's less chance to get distracted and makes you feel a lot

ABOVE Sidekick aims to provide a distraction-free environment.

less tired."

Tab management is also different to conventional browsers, something that's a common theme among all the power browsers in this feature. Sidekick groups tabs into "sessions". So, you might have a session for one work project and a separate session for another, or you might have a session of tabs that contain BBC Sport, Amazon and other things that you typically browse during your lunch break. Again, the aim is to avoid losing focus.

I told Pushkarev about my little work tactic of keeping a couple of personal tabs open in the background, and then rewarding myself for five minutes every hour by reading football match reports or watching a YouTube video. He laughed and then explained why that wouldn't work for people like him. "For people with ADHD, those five minutes can easily become three hours, and maybe even more, and then you suddenly find it's two in the morning and you're looking for some archaeological data or you're on the Wikipedia article for Sudan. And you're like 'how did I get here?' and then you remember you actually started by trying to figure out some dashboards for the company. Not having those distractions is very, very useful, especially if you are easily distracted.

"For many people, keeping focused for even five minutes is

"It blocks all requests that are not important to render the page... as a result we use a lot less memory and load the page faster"

a challenge," he added. "I know these people first-hand, and for them life is virtually impossible without medication."

Earlier this year, the company added another feature to help people whose attention wanders. "We released a task tracker with a built-in Pomodoro timer," he said, referring to the technique where you break down tasks into intervals of 25 minutes, followed by a short break. "Now you can say 'right now, I'm going to focus on this interview. I'm sticking with my screen saying [because] that's exactly what should be done at this point.'"

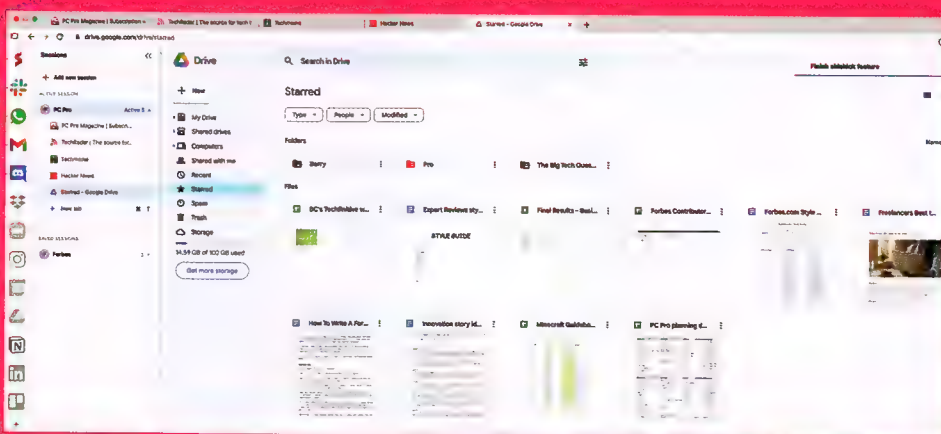
Sidekick offers a free version of the browser, but that's limited to five apps being pinned to the side of the screen and has other limitations. The Pro version costs US\$10 per month, and there's a Team version that can be used within companies with pre-installed apps, built-in VPNs and other collaboration features.

I put it to Pushkarev that convincing people to pay for a browser after they've been free for the best part of 30 years will be a challenge. "It's probably your most important application," he replied. "This is the tool where you spend six, eight hours a day, and even small changes to this tool make a huge difference. In fact, we did a survey and 80% of our users reported that they see substantial improvements to productivity when they use Sidekick."

If that proves to be the case, paying for a browser might not seem like such an extravagant idea after all.

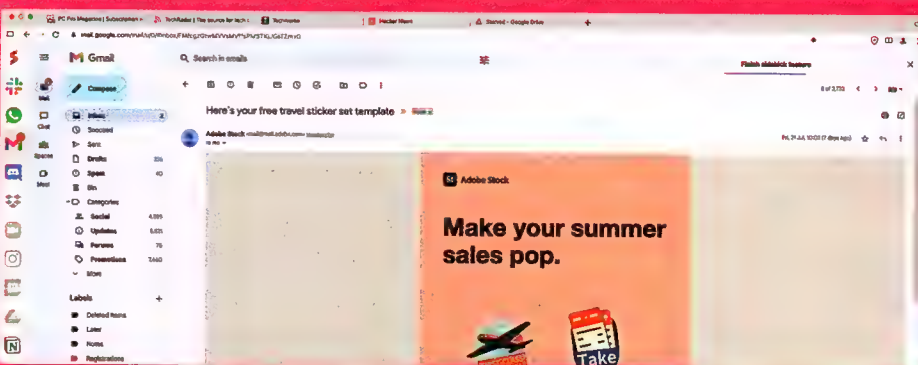
Sessions

Tabs are grouped into sessions, which can be easily renamed for specific tasks, such as "APC work". Only those tabs open in the current session are visible in the tabs bar at the top of the screen, with the aim of stopping you wandering off to check the football scores or Twitter updates. You can easily switch to different sessions from the sidebar or with a keyboard shortcut (Alt+W on Windows). Note also the timer showing the current task coming to an end in the top-right of the browser window.



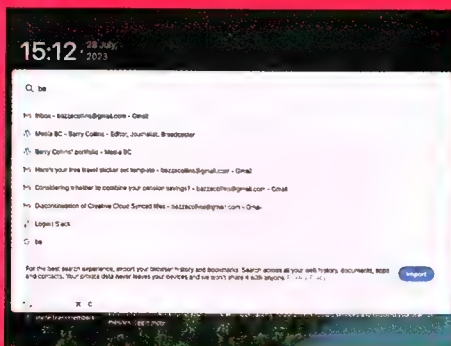
Apps sidebar

Web apps are contained in a sidebar down the left-hand side of the browser window. Here you'll still get notifications showing the number of unread Gmail or Slack messages, for example, but these can be easily turned off to avoid unwanted distractions. Apps don't get their own tab, so they take up less space at the top of the screen and avoid clutter.



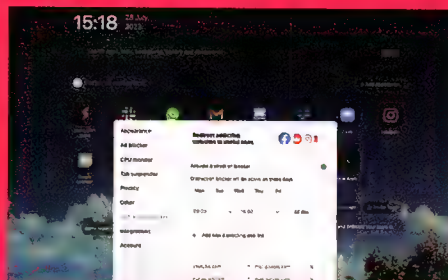
Universal search

The browser's search menu, found by opening a new tab, can search across open tabs, apps, documents and browser history to help you find things more quickly. As you can see from the screenshot, results appear instantly as you begin typing a search query, and it's easy to see which application the results are being sourced from.

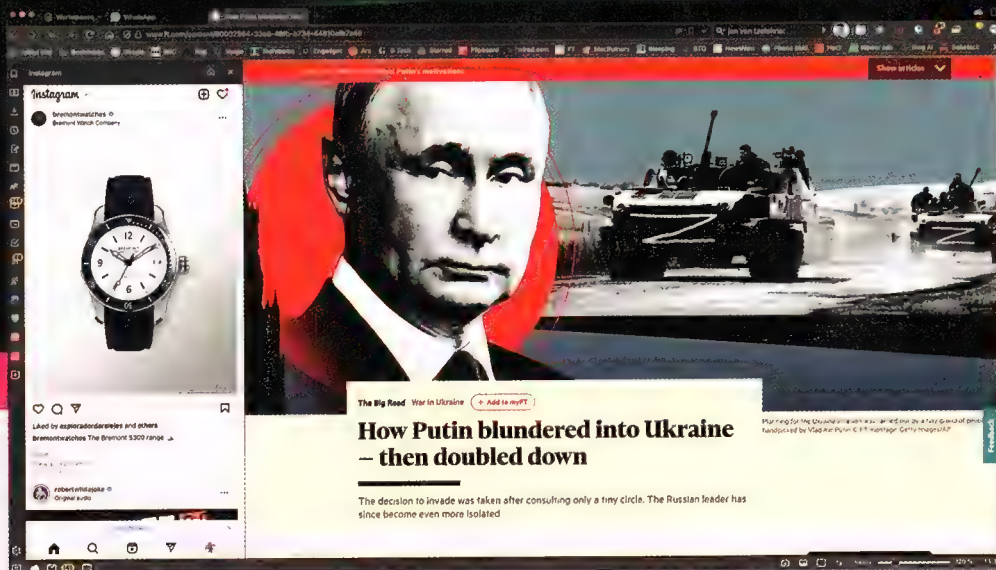


Distraction blocker

The Distraction Blocker can be activated manually or according to a schedule. So you might have it switched on between 9am and 5pm on weekdays, when you're meant to be focused on work. It can be set to automatically redirect you away from time-sucking websites. Those distractions and redirects can be customised, in case you have a particular weakness for the websites of non-league football clubs during work hours, say.



VIVALDI



ABOVE Feature-packed Vivaldi relies heavily on user feedback.

With a full-blown email client, calendar with offline access, RSS reader, task manager, notes app and lots more available through extensions, it's tempting to ask whether Vivaldi is more of an operating system than a web browser.

The company isn't blind to the complexity of its offering. When you first install Vivaldi you're given three layout options: Essentials, Classic or Fully Loaded. Essentials hides pretty much everything bar the basic browsing tools; Classic adds a few more advanced features, such as Web Panels (see opposite) and the browser's fast-forward and rewind buttons; Fully Loaded gives you the lot.

But if you're looking for an apology from Vivaldi CEO, Jon von Tetzchner, for packing the browser with lots of different features, you'd best bring a good book; you'll be waiting a long time. He launched Vivaldi in 2015 with the clear idea of making a highly customisable, privacy-first browser that stood apart from the feature-stripped mainstream browsers of the time. Getting on for ten years later, he's created a browser that's different from anything else on the market, even if he now believes others are "borrowing" Vivaldi's ideas.

"If you look at a lot of the features

that are being added by our competitors, and even some of the new ones, a number of them are basically features that we have that they've taken and maybe made some changes to," von Tetzchner told APC. "I'm not saying we innovated everything and everything is basically ours, but it is interesting. Some are adding [features] like tab tiling, and we've been doing that for quite some time. Suddenly, a number of the browsers have been adding panels on the right side or they're providing vertical tabs. We were the only ones that were doing those things."

How does Vivaldi decide which features to add to its browser? "It's a process where we work with the user base quite closely," said von Tetzchner. "Some of the ideas are just people asking for features, that happens. Typically that would be features that you would find in old versions of Opera," he added, Opera being the browser he co-founded in the early 1990s, before falling out with the browser's new owners in 2011.

"Then there are people having ideas internally," von Tetzchner added. "We have a concept of 'brains think better than the brain'. So, anyone could

come up with an idea and sometimes it's a developer that just implements something and they say, 'hey, I made this prototype, what do you think?' And if there's agreement that it's a good idea then we go and implement it further. So, it's less structured. I think it's very difficult to plan everything."

Vivaldi relies heavily on feedback from user groups when implementing new features. And while von Tetzchner concedes there are dangers in relying too heavily on the feedback of a group of super-engaged, technically literate beta testers, he said there are big advantages from listening carefully to that group, too. "We are always getting feedback from those natural users," he said. "Yes, they are more advanced than the rest, but at the same time, we are building a browser that probably some of the more advanced users will really appreciate, because we have a lot of features that you don't find anywhere else. So, from that perspective, this is a very relevant group for us to test."

However, there will inevitably come a time with such a feature-packed browser that features have to be removed to keep the code base lean and manageable. Vivaldi makes a big play of not tracking its users' behaviour, so how does the company

"If you look at a lot of the features that are being added by our competitors, a number of them are basically features we have that they've taken"



Vivaldi facts

Supported OSes: Windows, Mac, Linux, Android, iOS (in beta)

Browser engine: Chromium

Support for browser extensions: Yes (Chromium)

Founded: 2015

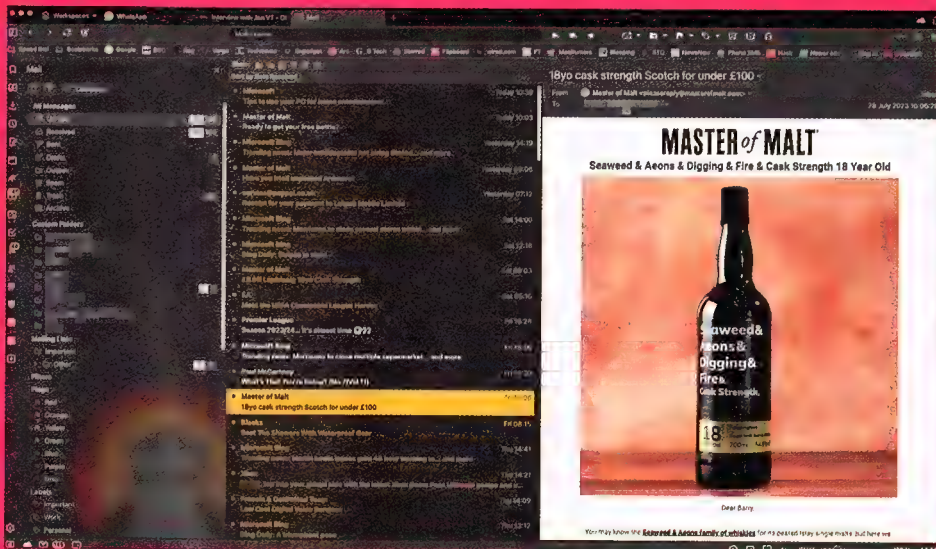
decide which features to eliminate when it doesn't have a barrage of analytics to be sure that a certain feature isn't widely used? Von Tetzchner admits that it's difficult.

"Typically, when we try to remove [a feature], we actually find out it's the favourite feature for a certain group of people," he said. "Which is why we then end up removing it as a default feature but keeping it around as an option, which doesn't need to be that expensive a thing to do. But obviously, is there a limit? Yes. And sometimes we find that we can actually remove features if we're providing a better way to do things, which everyone agrees is better."

It's not only the feature set of Vivaldi that's constantly expanding, it's the number of devices it supports, too. Aside from the desktop browser for Windows, Mac and Linux, it launched an Android version in 2020, and this is also widely used to provide browsing capabilities for in-car systems. At the time of writing, Vivaldi was gearing up to launch an iOS version as well, having long resisted Apple's demands to use its WebKit framework. "We don't get the benefit of having the same codebase," said von Tetzchner, "but we're still trying to make sure that the functionality that you're used to having is there and it's recognisable."

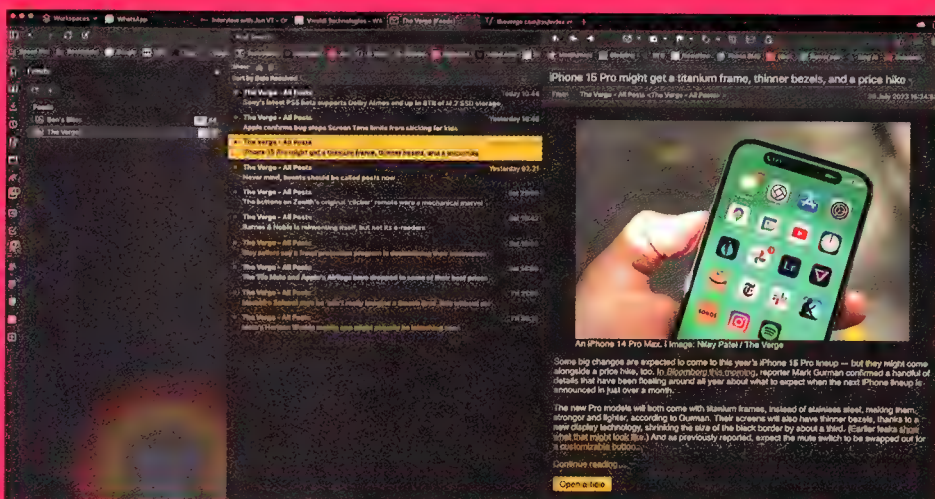
Email client

Vivaldi's email app isn't merely a shortcut to webmail, which you might find in other browsers. It's a full-blown email client for webmail accounts, as well as IMAP/POP3. It offers full offline access, filters, search and support for multiple accounts. Notifications of unread messages appear in the sidebar, and you can alter the frequency for which it checks for new messages, among many other settings.



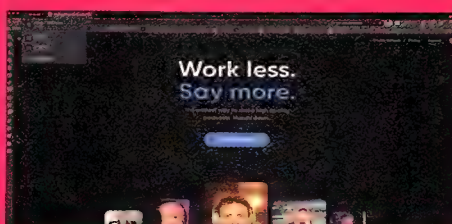
RSS reader

RSS feeds are still a convenient way of keeping on top of updates from websites, newsletters and suchlike. Vivaldi's RSS reader is a little awkwardly integrated with the email client, although if you fiddle with the settings you can keep them separate. You can choose how often Vivaldi checks for new updates when you subscribe to a feed, with options ranging from every five minutes to weekly.



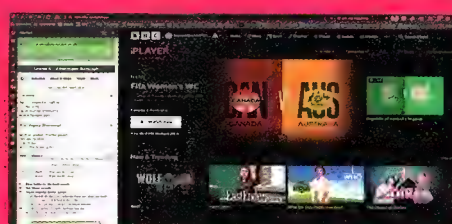
Workspaces

Workspaces basically bring the concept of virtual desktops to browsers, where each workspace gets its own set of tabs (think Work, Shopping, Holiday), allowing you to keep groups of tabs isolated from another. Workspaces can be easily renamed and assigned a custom icon.



Web Panels

Web Panels create a pane at the side of the screen that you can use to, say, keep an eye on live football results, stock prices or social media while you get on with stuff in the main window. They're normally treated like mobile browsers, so content is reformatted to fit the pane.



System News

PC part prices are back to normal, except for GPUs, Mark Williams explores why that is.



Mark Williams
Mark is an IT professional with a strong interest in voiding warranties.

The overpriced graphics card market has been with us now for what feels like ages. Several years of overpriced graphics cards hasn't been kind to PC gaming enthusiasts. One reason has been the extended lifespan of the RTX 3000 and RX 6000 lines of GPUs, which are going on three years old yet still being sold brand new.

Following the COVID boom for GPUs AMD and Nvidia have been left with so much stock to sell, it's made it very difficult for either to launch new generation GPUs to replace the aging ones. The new cards are

technically better and faster for the most part but are being sold at a proportionally higher price so the value of the new cards in real terms hasn't improved from the last generation, leaving us

feeling equally excited but also disappointed.

While the upper-tier cards (that have "8" or "9" in their names) from both AMD and Nvidia from the past generation have basically dried up, the entry and mid-tier cards (that

have "6" or "7" in their names) are still plentiful and will be on sale for quite a while yet, though it seems like they should be mostly sold out by the end of this year.

When the last generation cards finally sell out though does that mean the newest generation cards will then come down in price? Not necessarily.

While it'll clear the market price floor, every generation of GPU has been slowly getting more expensive. Even though AMD has been the better of the two at keeping pricing reasonable Nvidia hasn't been shy in ratcheting up prices for its latest and greatest parts. And now that AI is taking the world by storm Nvidia is keen to shift as much silicon production and software engineering time to cater for that at the expense of gamers.

SHOP TALK

How well are the remaining RTX 3000 and RX 6000 series cards selling, and when do you see them finally drying up?

Richard, Aftershock PC: "We have found the remaining lower-end RTX 3000 series and RX 6000 series cards have been selling exceptionally well for the last couple of months. The lower-end 3000 series are starting to dry up now and as they reduce, we are seeing the uptake of 4060, 4060Ti and RX 7600 taking their place. We expect that within another month or so we likely won't be selling any more 3000 series cards. To date, there still seems to be plenty of RX 6000 stock around and it still seems to be selling well, so I would imagine that will probably continue for some time."

Nvidia driver programmers have stated that they've seen a reduction in game-ready driver spending lately, leading to a not-so-great performance showing with the *Starfield* game launch.

AMD's recent announcement of its RX 7700 XT and RX 7800 XT mid-tier cards has at least put pressure on Nvidia to rectify its absurd pricing with the RTX 4060 Ti 16GB.

With any luck after this generation, we'll see a return to the typical increases in cost-to-performance uplifts we're used to, but with newer process nodes getting more and more expensive it'll be a big factor that'll prevent newer generations of GPU from getting as cheap as they once were. Something that AMD's chiplet strategy could pay dividends on for consumers. Time will tell.



Market Watch

A sampling of PC systems available this month.



THERMALTAKE GENESIS XTREME V3

\$1,649 | tinyurl.com/APC525TT

If you're looking to play the latest eSports titles this system is a good entry point. It's based largely on last-gen parts that keeps this rig's price down, while giving you enough performance for any eSports title to be run at 1080p at high refresh rates. The CPU is a bit stronger than what's found in the equivalently priced Aftershock Flux system, which will be a benefit in typically CPU-bound eSports titles, however the RTX 3060 is substantially weaker than what's in the Aftershock system. RAM and SSD capacities are good at this price though the aging GPU, in the latest triple-A titles, will struggle. Overall, this system is slightly overpriced but not bad.

CPU: Intel Core i5 12400F; **Cooler:** Thermaltake UX200 SE ARGB; **Motherboard:** B660M chipset based with WiFi; **Graphics:** GeForce RTX 3060; **Memory:** 16GB Thermaltake Toughram Z-ONE RGB DDR4 3200MHz; **Storage:** 1TB M.2 NVMe SSD; **Power Supply:** Thermaltake Smart BX1 650W; **Case:** Thermaltake V150 ARGB Breeze.



AFTERSHOCK PC FLUX

\$1,599 | tinyurl.com/APC525AFT

Sporting the latest entry-level GPU from Nvidia, this system off the bat has at least twenty per cent more gaming performance on tap relative to the slightly more expensive Thermaltake system. The CPU is fractionally weaker but not by so much that you'd notice. The pairing of very high frequency RAM, however, will likely help offset any differences. With the same RAM and SSD capacities but a substantially higher wattage PSU, this system pulls ahead of the Thermaltake offering quite easily in value for money by being more capable in games while costing less. An easy choice for competitive gamers on a budget!

CPU: AMD Ryzen 5 5600; **Cooler:** Aftershock M-42 Frost Air Cooler; **Motherboard:** Gigabyte B550M DS3H AC; **Graphics:** MSI RTX 4060 Ventus 2X Black OC 8GB; **Memory:** 16GB Gigabyte Aorus RGB 3733MHz; **Storage:** 1TB MSI Spatium M461 M.2 Gen4 NVMe SSD; **Power Supply:** Cooler Master V850 850W; **Case:** Asus Prime AP201.



PC CASE GEAR VENGEANCE 4080

\$4,499 | tinyurl.com/APC525PCCG

When looking at sensibly priced high-end PC offerings something like this is hard to look away from. The CPU is perfect for gaming and moderate amounts of productivity work, as is the RTX 4080 GPU for any CUDA accelerated workloads making this system great for work and play. Water cooling is a must with Intel's latest CPUs which get toasty a little too quickly, so it's good a solid AIO is included. The 32GB RAM, 2TB SSD and 850W PSU capacities match the PLE system, while coming in slightly cheaper overall. While not strictly a gaming-focused weapon like the PLE rig is, this is basically just as capable in games while offering more productivity chops at a lower price.

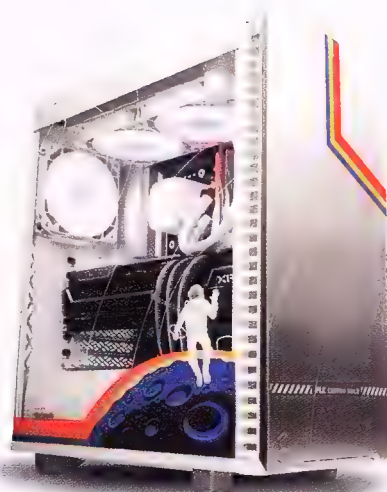
CPU: Intel Core i7 13700KF; **Cooler:** Corsair iCUE H100i Elite Capellix XT 240mm RGB AIO; **Motherboard:** Asus Prime Z790-P Wi-Fi CSM DDR5; **Graphics:** Asus ROG Strix GeForce RTX 4080 OC 16GB; **Memory:** 32GB Corsair Vengeance RGB 6000MHz CL40 DDR5; **Storage:** Corsair MP600 GS PCIe Gen4 M.2 NVMe SSD 2TB; **Power Supply:** Corsair Shift RM850x 850W; **Case:** Corsair iCUE 4000D RGB Airflow.

PLE COMPUTERS AIRLOCK

\$4,593 | tinyurl.com/APC525PLE

With *Starfield* released now, it's inevitable to see a *Starfield*-themed PC. This delivers in spades. The game is quite demanding, so having the best system goes along with that. AMD graphics cards have the advantage in this game currently, so the RX 7900 XTX here is perfect for any resolution or refresh rate you're after. Paired with the mighty Ryzen 7 7800X3D CPU is the perfect choice here to maximise performance. The large 2TB SSD will eat up *Starfield*'s large install size and not even blink. 32GB of 6000MHz RAM is the sweet spot for Ryzen 7000 too. All housed in a custom *Starfield*-themed case, this is the perfect rig to experience the game's universe with.

CPU: AMD Ryzen 7 7800X3D; **Cooler:** EK Nucleus 240mm Lux D-RGB AIO; **Motherboard:** Gigabyte B650 Aero G; **Graphics:** XFX Radeon RX 7900 XTX Speedster Merc 310 24GB; **Memory:** 32GB G.Skill DDR5 Trident Z5 RGB C36 6000MHz; **Storage:** 2TB Kingston NV2 PCIe Gen4 NVMe M.2 SSD; **Power Supply:** be quiet! Pure Power 12 M 850W **Case:** Fractal Design Define 7 Compact TG.



Blueprints

Value- and performance-driven hypothetical builds

BUDGET

A perfect balance between price and performance.

Our budget machines may not be the best of the bunch, but the fact you can piece together a whole machine costing around two-thirds of the price of just one 4090 is crazy. And that whole machine is capable of 1080p gaming on ultra settings too – it's a whole lot better value for money. After our previous two Budget builds, we decided it was time to bring some new components into the mix. While the Intel Limited Edition Arc A750 8GB can game at 1080p, the RTX 4060 we tested recently does so at much higher frame rates. With the help of DLSS 3.0, we reached over 200fps on Cyberpunk with ray tracing and we won't get that with the Intel card. The MSI Ventus 2X Black OC costs \$160 more, but it's worth every cent for the consistent Nvidia support and AI tech.

We've kept the impressive entry-level Intel Core i3-13100F CPU that we introduced last time. At \$179, it's a great way to experience 13th-gen Intel technology, it's power efficient and works well in a 1080p gaming machine. Another component we introduced was the Lexar NM790 SSD. This 1TB drive comes in at \$69 and doubles our capacity for no extra cost over the Corsair SSD. We also added the Lexar to the AMD side and a new PSU to both. The Thermaltake Litepower Gen2 450W was out of stock so we swapped it out for the 600W EVGA 600 BR and an extra \$24.

Aside from the PSU and SSD change on the AMD machine, the only other component we swapped out was the GPU. Out goes the Radeon RX 6600XT and in comes the Asrock Phantom Gaming OC Radeon RX 7600. An 8GB card



may raise some issues, but the newer generation card outperforms the 6600XT and is a strong competitor against the RTX 4060. With a new SSD, PSU, and GPU, our AMD machine has gone up by \$194. The Intel build increased by \$174.

Note our \$60 Windows 10 Home price is based on an average cost of OEM keys you can buy online, with around half that price not being uncommon.

AMD INGREDIENTS

Part		Price
Case	Corsair 4000D Airflow	\$149
PSU	600W EVGA 600 BR 80+ Gold NEW	\$79
Mobo	MSI B550M PRO-VDH WIFI Micro ATX AM4 Motherboard	\$129
CPU	AMD Ryzen 5 5600	\$209
GPU	Asrock Phantom Gaming OC Radeon RX 7600 8GB NEW	\$529
RAM	16GB (2 x 8GB) PNY XLR8 Gaming Epic-X RGB DDR4 @ 3600MHz	\$89
SSD	1TB Lexar NM790 PCIe 4.0 M.2 SSD NEW	\$65
HDD	2TB Seagate Barracuda Compute 7200	\$69
OS	Windows 10 Home 64-bit OEM (Windows 11 Compatible)	\$60
Total		\$1,378

INTEL INGREDIENTS

Part		Price
Case	Corsair 4000D Airflow	\$149
PSU	600W EVGA 600 BR 80+ Gold NEW	\$79
Mobo	Asrock B660M Pro RS Micro ATX GA1700	\$199
CPU	Intel Core i3-13100F	\$179
GPU	MSI Ventus 2X Black OC GeForce RTX 4060 8GB NEW	\$509
RAM	16GB (2 x 8GB) PNY XLR8 Gaming Epic-X RGB DDR4 @ 3600MHz	\$89
SSD	1TB Lexar NM790 PCIe 4.0 M.2 SSD NEW	\$65
HDD	2TB Seagate Barracuda Compute 7200	\$69
OS	Windows 10 Home 64-bit OEM (Windows 11 Compatible)	\$60
Total		\$1,398



"Despite the Intel Core i5 12600K still being mighty impressive, we are bringing in the 13th-generation variant in its place."

MID-RANGE

A game-ready machine that can also handle demanding work.

Moving up to the next level, our Mid-range machines enter into the QHD category of gaming. Not only are they more than enough for competitive and high-quality casual gaming experiences but also commercial creative work. Here, we are aiming to improve these great all-rounders by adding a few premium components.

Despite the Intel Core i5 12600K still being mighty impressive, we are bringing in the 13th-generation variant in its place. This costs \$100 more but inevitably brings more power, with more cores and threads and stronger overclocking potential. We were always huge fans of the 12600K and the 13600K takes all that was great about

that chip and improves upon it.

As before, we brought in the 1TB Lexar NM790 SSD as this was too good to pass up. With read and write speeds of 7400MB/s and 6500MB/s, it's overkill for our budget machines and more appropriate for the mid-range machines. However, we couldn't exclude it from both due to its great value performance. Apart from that, the Intel machine remained the same. There were no real component price changes. The overall cost of the mid-range Intel build went from \$2,215 to \$2,377.

Moving over to team AMD, we're keeping the CPU firmly in place this time but making our main alteration to the

GPU. We did consider swapping out the Asus Radeon RX 6750 XT Dual OC 12GB we added last issue for a 6800 XT-based card, but that GPU has disappeared completely from the Australian market. We suspect that AMD's yields are very high for that GPU so they're being sold mostly as the ever so slightly cut down 6750 XT instead. Still, it offers a solid QHD gaming experience. As we mentioned earlier, we brought in the Lexar SSD here too but besides that, the rest of the AMD mid-range machine stayed the same.

This meant that the overall cost of our AMD competitor went up from \$2,056 to \$2,153.

AMD INGREDIENTS

Part		Price
Case	Nzxt H7 Flow	\$199
PSU	750W EVGA 750 G5 80+ Bronze	\$179
Mobo	Asrock B650M PG Riptide Wi-Fi Micro ATX AM5	\$315
CPU	AMD Ryzen 5 7600X	\$389
Cooler	MSI MAG Coreliquid 240R V2	\$129
GPU	Asus Radeon RX 6750 XT Dual OC 12GB	\$589
RAM	32GB (2x 16GB) Corsair Vengeance DDR5 CL40 @ 4800MHz	\$159
SSD	1TB Lexar NM790 PCIe 4.0 M.2 SSD NEW	\$65
HDD	2TB Seagate Barracuda Compute 7200	\$69
OS	Windows 10 Home 64-bit OEM (Windows 11 Compatible)	\$60
Total		\$2,153

INTEL INGREDIENTS

Part		Price
Case	Nzxt H7 Flow	\$199
PSU	750W EVGA 750 G5 80+ Bronze	\$179
Mobo	Gigabyte Z790 UD AX ATX LGA 1700	\$349
CPU	Intel Core i5-13600K NEW	\$489
Cooler	MSI MAG Coreliquid 240R V2	\$129
GPU	MSI Ventus 2X Black OC GeForce RTX 4060 Ti 8GB	\$679
RAM	32GB (2x 16GB) Corsair Vengeance DDR5 CL40 @ 4800MHz	\$159
SSD	1TB Lexar NM790 PCIe 4.0 M.2 SSD NEW	\$65
HDD	2TB Seagate Barracuda Compute 7200	\$69
OS	Windows 10 Home 64-bit OEM (Windows 11 Compatible)	\$60
Total		\$2,377



"There were no significant price fluctuations on the other components and as we recently overhauled many of the components of both Turbo builds, we didn't feel the need to change much."

TURBO
The maximum PC.

Turbo machines mean ultimate performance. We do also bear the budget in mind, but there's a lot more financial leeway with these builds. One of the biggest issues we face is how often the market fluctuates between these guides, so we aim to make the best decisions we can at the time of writing. Our Turbo builds are designed to be the most fun and allow us to construct something approaching our ideal build, so let's get straight into it, starting with the AMD system. Last time around, the Gigabyte Radeon RX 7900 XTX Gaming OC 24GB GPU was just about the cheapest variant available and that remains the same. This 24GB

card packs an almighty punch and, being a 7900XTX, it sits at the top of the AMD GPU hierarchy. It's also far cheaper than the competitor on the Intel/Nvidia side, the RTX 4090. Turning our attention to the CPU, this is still the most powerful AMD chip available, so we knew we wanted to keep it in place. There were no significant price fluctuations on the other components and as we recently overhauled many of the components of both Turbo builds, we didn't feel the need to change much. So, for the AMD Turbo machine, nothing was swapped out and the overall price went up by a meagre \$15. This is one impressive PC!

We applied the same thinking to the Intel Turbo machine, keeping the Zotac GeForce RTX 4090 Gaming Trinity OC GPU in place as this was still the cheapest RTX 4090 available – if you can call \$2,729 cheap! Alongside our RTX 4090 is the Intel Core i9-13900K, which increased in price by a barely noticeable \$10 from its previous price of \$889. While we're used to the price of components fluctuating, it seems like most of them have crept back up slightly this month. There are no further changes we can make to bring the price down on this Intel PC, so with a total cost of \$5,641, it has gone up by over \$40.

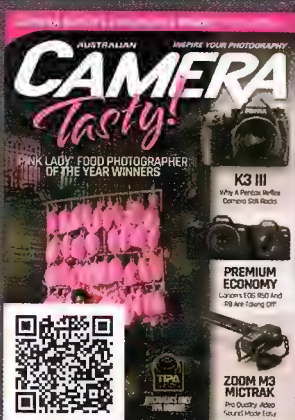
AMD INGREDIENTS

Part		Price
Case	Phanteks Enthoo Pro 2 Tempered Glass	\$299
PSU	1000W Nzxt C1000 80+ Gold	\$239
Mobo	Asrock X670E PG Lightning ATX AM5	\$539
CPU	AMD Ryzen 9 7950X3D	\$1,085
Cooler	Nzxt Kraken X73 RGB 360mm	\$329
GPU	Gigabyte Radeon RX 7900 XTX Gaming OC 24GB	\$1,599
RAM	64GB (2x 32GB) Corsair Vengeance DDR5 CL40 @ 5200MHz	\$279
SSD	2TB WD Black SN850X M.2 PCIe 4.0	\$309
HDD	6TB WD Blue 5400 HDD	\$179
OS	Windows 10 Home 64-bit OEM (Windows 11 Compatible)	\$60
Total		\$4,917

INTEL INGREDIENTS

Part		Price
Case	Phanteks Enthoo Pro 2 Tempered Glass	\$299
PSU	1000W Corsair RM1000x Shift 80+ Gold	\$289
Mobo	Gigabyte Z790 UD AX ATX LGA 1700	\$339
CPU	Intel Core i9-13900K	\$899
Cooler	Nzxt Kraken X73 RGB 360mm	\$329
GPU	Zotac GeForce RTX 4090 Gaming Trinity OC 24GB	\$2,729
RAM	64GB (2x 32GB) Corsair Vengeance DDR5 CL40 @ 5200MHz	\$279
SSD	2TB WD Black SN850X M.2 PCIe 4.0	\$239
HDD	6TB WD Blue 5400 HDD	\$179
OS	Windows 10 Home 64-bit OEM (Windows 11 Compatible)	\$60
Total		\$5,641

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QUICK TIPS

The problem solvers

The APC team field problems across the spectrum of devices and software.

Learn a new trick or fix you can use.

EmulationStation DS query

I was intrigued by EmulationStation DS for retro gaming. I set up Batocera Linux, love the ES user interface, and I'd like to replicate that on my PC. Is it really such a hassle to set up the DS version in a standard Windows installation?

Jon R Hurst

APC responds: The biggest issue with the DS build of EmulationStation (ES) is that you must install and configure RetroArch, the underlying tool powering your various emulators, separately. There's a lot of configurability beneath the hood, and it'll take some trial and error to get things working the way you want them to. However, as a quick guide, start by downloading and installing RetroArch from www.retroarch.com – we recommend the 64-bit installer for maximum emulator support.

Once installed (there's no need to select DirectX during the installation process), launch RetroArch. Navigation can be done using the mouse, keyboard, or any controller you've installed. Select Load Core, followed by Download a Core to download, and install your choice of emulators from the list. If you're looking to emulate arcade machines, we recommend MAME 2003-Plus as the one most likely to work with the widest range of games.

With some emulators – including MAME – that's all you need to do. Others – including Hatari (Atari ST) and PUAE 2021 (Commodore Amiga) – require you to source ROMs separately and place them in a specific folder, which you can determine by visiting <https://docs.libretro.com/guides/install-windows/> and exploring the 'Core Library: Emulation' section. Once you've sourced the files and placed them (typically C:\RetroArch-Win64\system) navigate to 'Settings > Core > Manage Cores' and select the emulator to verify that it registers the required files as present.

Other sections you need to visit include Settings > Input, where you can configure your controller, as well as RetroArch's own hotkeys, which allow

you to access such controls as fast forward, pause, and a mini menu. By default, these keys override any customisations you make for game control, so we recommend selecting 'Hotkeys > Hotkey Enable' and setting a key like Windows, which you'll need to hold down in conjunction with the other hotkeys to trigger them. Also, check out 'Port 1 Controls', where you can configure keyboard mapping for game controllers alongside your existing controller.

Then, head to Settings > Video > Fullscreen Mode, and set Fullscreen Mode to On – this is required for ES DS to work correctly. Once done, you can quit (press Esc, then Esc again).

Next, download and install ES DS (www.es-de.org). After installing, launch the program and select 'Create Directories', followed by OK, Yes, and Quit. Copy your ROMs to the relevant subfolder inside C:\Users\{username}\

ROMs, relaunch ES and wait while it scans for games. Press Esc (or the Start button on your controller) to bring up its menu. Navigate to Other Settings > Alternative Emulators, and select the correct emulator for each platform. You should now be able to play any detected

games, but be prepared to spend some time in both RetroArch and ES familiarising yourself and getting things set up just the way you like them.

MKV or MP4?

I'm as frustrated as you are that there's no simple subtitling solution for Windows. I know Plex can automatically find subtitles for most shows and movies, but I'd like a local fallback option from my HD rips. It occurs to me that the problem lies with the MP4 format's inability to handle image-based subtitles, while MKV files work just fine. Is there actually any pressing need for me to output in MP4, or can I get away with just ripping to MKV format?

Sheri Miller

APC responds: In theory, there shouldn't be any problem outputting to MKV rather than MP4: MKV supports the same underlying audio and video

codecs as MP4, so in theory Plex should handle the format. However, it comes down to a combination of what file types (as opposed to codecs) are supported by your playback devices, along with your personal preferences and priorities.

MP4 is more widely supported – particularly on mobile devices, so if you're streaming to multiple devices (or indeed sharing your library with others), you're less likely to run into problems or complaints from friends when Plex is forced to either direct stream or transcode the files before streaming them, which may lead to errors or buffering. However, you can minimise this by ensuring your MKV files – like MP4 – are encoded using standard codecs, which we recommend as H.264 for video, and AAC or AC3 (or better still, one of each) for audio.

On the other hand, if you're the only user and your server can transcode or remux MKV files on the fly without too many problems, there are two major advantages to switching to MKV. First and foremost, you won't need to worry about converting image-based subtitle tracks – including those that contain icons and other graphics. Secondly, while Plex ignores any custom audio track and subtitle titles in MP4 files, it will display that information in MKV files, which means you can provide descriptive names for your tracks (such as a commentary track) and easily identify them within Plex itself.

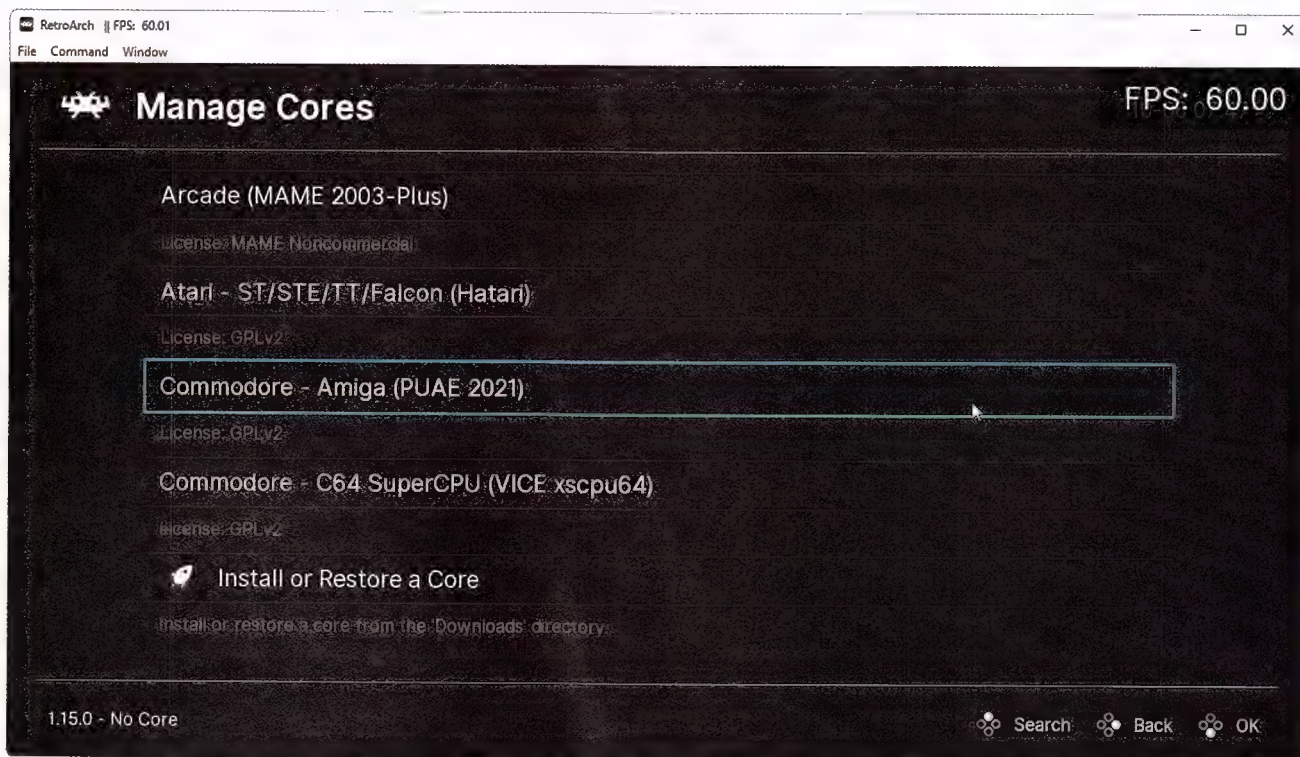
Recover bricked router

My Synology RT2600ac router has served me well over the years, but I'm afraid that it has reached the end of its life. I don't know if it was linked to a recent firmware update or not, but whatever I do, I cannot access it, even though the status light flashes green. I've tried restarting it multiple times, and resetting it, all to no avail. Right now, I'm connecting to the internet through my phone's mobile hotspot capabilities. Do I need a new router?

Graham Francis

APC responds: We suspected the process of resetting the device had made it impossible for Graham to connect to using his previous network settings. We directed him to Synology's Synology Assistant tool,

"I know Plex can automatically find subtitles for most shows and movies, but I'd like a local fallback option from my HD rips."



which although designed for its range of NAS devices, can detect routers too. Head over to www.synology.com/support/download, and select NAS followed by any model number, then switch to Desktop Utilities, where you'll find a download link.

Once downloaded, you'll need to connect your PC directly to the router via a LAN cable, but you need to make sure it's plugged into the router's blue WAN socket instead of one of the yellow LAN ports. Now, simply install and run Synology Assistant on that computer, and let it search for your router. Graham was able to report that it not only detected his router, but was able to help him set it up again in order to restore his home network.

Mac boot glitches

Hi, I don't know if you can help me. I've been given an old MacBook Pro (2012 vintage), and I want to wipe it clean and start again. I've successfully created a macOS installer flash drive, but try as I might, I cannot seem to get the MacBook to boot to the start-up disk selection screen. However, I try holding the Option key, it just bypasses it and goes straight to login screen – the same happens when I try to boot to recovery mode (Apple + R). Is there some way to force the Mac to boot in either mode without me having to get involved?

Lance Rabago

APC responds: Ah yes, Macs are notorious for refusing to work with the very key combos Apple builds into them. This is linked to the NVRAM – a

Retroarch underpins many gaming frontends on the PC.

small portion of memory that the Mac uses to store certain system settings. You can try to reset this as well as PRAM, which stores similar settings, but guess what? It relies on the same keys your Mac is ignoring at boot.

Thankfully, all is not lost – while the Mac doesn't have an equivalent to Windows' useful msconfig utility, it is possible to force it to reboot in either mode through the Terminal. Open this via Applications > Utilities, and then issue the following command to force it to display the boot manager:

```
sudo nvram
manufacturing-enter-
picker=true
```

When prompted, enter your user password. Now, reboot your Mac, and you'll go straight to the start-up selection screen. Note, this setting will remain in place every time you boot until you remove it:

```
sudo nvram -d manufacturing-enter-picker
```

As an aside, the following command lets you reboot into recovery mode:

```
sudo nvram recovery-boot-mode=unused
```

When you're done in recovery mode, open a Terminal window via Utilities, and issue the following command so you can reboot into normal mode:

```
nvram -d recovery-boot-mode
```

Finally, to clear the contents of NVRAM:

```
sudo nvram -c
```

"I've been given an old MacBook Pro (2012 vintage), and I want to wipe it clean and start again."

Note: performing this final step will wipe certain settings from System Preferences, so be prepared to have to reapply favourite tweaks when you're done.

Another PrtScr hijack

I read your reply to Emory Allen about removing OneDrive's hijacking of the Print Screen key. I accidentally pressed Print Screen before launching my screen capture tool, and now it appears the Snipping Tool has taken it. Even after I close the

window, then close and restart my screen capture tool, it refuses to give up the Print Screen capture tool. I can restart my PC, but is there another way?

Loren Leach

APC responds: A

recent Windows 11 update changed the mapping of the Print Screen key to Windows' own Snipping Tool. It's supposed to respect any existing mappings, but if you've recently installed an update, it's possible that Windows has hijacked control of the keyboard shortcut.

Thankfully, the fix is simple: navigate to 'Settings > Accessibility > Keyboard', scroll down and flick the 'Use the Print screen key to open Snipping Tool' to Off. Once done, relaunch your tool, and you should find it now has control of Print Screen again. ■

WINDOWS

Make Windows better

Expert tips for a better experience.

WINDOWS 10 & 11

End PC resources using the Xbox Game Bar

The Xbox Game Bar is designed for gamers, but it includes widgets that anyone will find useful. One of these is the Resources widget, which shows how much of your PC's resources your running programs are consuming. Seeing this info in the Game Bar is quicker than opening Task Manager.

First, press Windows key+G to open the Game Bar. If the Resources widget isn't already open, click the bar-chart icon (1 in our screenshot below) to activate it. From here, click the X button next to any service to stop it running (2). You can also click 'Show More' to get more detail on which resources your programs are consuming under the headings CPU, GPU, RAM and DISK. Click the Pin button (3) to stick the Resources widget to your desktop, so it remains there when you close the Game Bar.

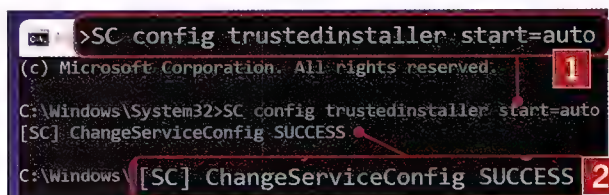


WINDOWS 10 & 11

Make your PC shut down after installing updates

The easiest way to install Windows updates is to select the 'Update and shut down' option from the Power button in the Start menu. But recently many users are reporting that their PCs reboot once the update has been installed, rather than shut down.

This happens because Windows regards 'Update and shut down' as a statement of preference rather than an instruction, and so sometimes may

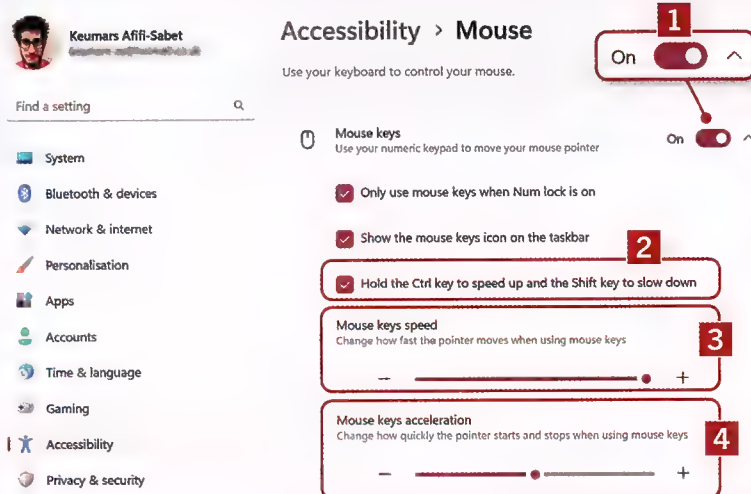


WINDOWS 10 & 11

CHANGE CURSOR SPEED WHEN USING MOUSE KEYS

The 'Mouse Keys' feature in Windows lets you press number keys on your keyboard to move your mouse cursor, but its speed might be too fast or slow when you first use it. To tailor its speed to your liking, first search for and then open Mouse Keys, then click the slider to On (1 in our screenshot). You'll now be able to move the cursor using numbers 1-9 (except 5), with each key corresponding with one of eight directions.

Next, tick the 'Hold the Ctrl key to speed up and the Shift key to slow down' (2) box. Now move the sliders below to adjust both the cursor speed (3) and its acceleration (4) – which is how quickly it starts and stops when you begin to use Mouse Keys.



choose to boot you into the login screen, meaning you have to log back in and manually shut down your machine.

One way to fix this bug is by running the Windows Module Installer (WMI), which helps to keep your computer up to date. You'll need to do this in Command Prompt, so search for 'Command', then click 'Run as administrator'. In the Command Prompt, type SC config trustedinstaller start=auto (1 in our screenshot below) and press Enter. This will trigger WMI to run in the background and check for updates. You will now receive

the message [SC] ChangeServiceConfig SUCCESS (2) if the command was entered successfully. Now exit Command Prompt, and select 'Update

and shut down' to see if the fix has worked.

WINDOWS 11 INSIDER See more details in File Explorer

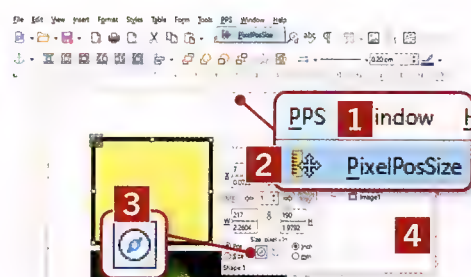
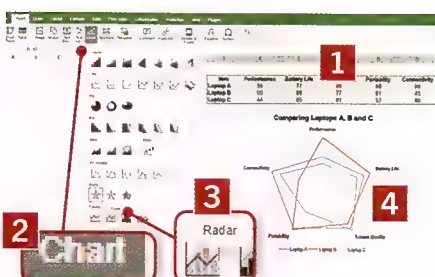
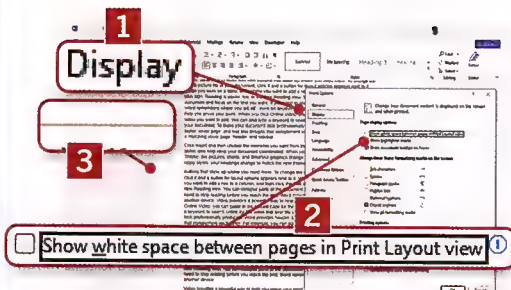
A recent preview version of Windows 11 (Build 21361.2050), available to Windows Insiders on the Beta Channel, added more information to File Explorer when you preview your documents. To see this info, select a document, then press the keyboard shortcut Shift+Alt+P and it will appear on the right.

As well as existing info like file title and size, you'll see whether it has been shared online (1 in screenshot above left), and if anyone has commented on the document. To become a Windows Insider, sign up at www.snipca.com/47105 – bear in mind that preview versions will contain bugs and shouldn't be used for critical work. ■



Make Office better

Top tips for the best office programs



MICROSOFT WORD & LIBREOFFICE WRITER

Hide white spaces in Print Layout mode

If you're writing in Word's Print Layout mode, regardless of whether you're actually planning to print your document, your pages will always appear with white spaces at the top and bottom, and a grey gap between them. Sentences that spill over pages will be divided by inches of empty space.

To hide these spaces, click File, then Options to open the Word Options box. Click 'Display' (1) in our screenshot below) then under 'Page display options' untick 'Show white space between pages in print layout view' (2). The blank spaces will now disappear, and pages will be separated by a line (3).

To do the same in LibreOffice Writer, click View on the toolbar and select 'Hide white space'. Note that LibreOffice Writer won't show a dotted line to separate one page from another - you'll need to click 'Show white space' to revert to your original view.

ONLYOFFICE

Use radar charts as a comparison tool

When you have multiple types of data to compare in a spreadsheet, consider showing them on a radar chart. These are suitable when you have multiple variables, making it easier to see strengths and weaknesses at a glance. Radar charts are one of the standout new tools in OnlyOffice 7.4, released 13 June.

In our example we want to compare several criteria for three laptops we're choosing between. Start by highlighting the cells containing the data J3:O6 (1) in our screenshot below). Next, click Insert on the toolbar, followed by Chart (2), then pick one of the Radar options (3).

There are three types of chart to choose - the basic Radar, 'Radar with markers' or 'Filled radar'. Selecting one will turn your data into a radar chart (4). You can then change its colours, font, text size and title. Laptop B, represented by the orange line, takes up most space in the chart, so overall that's our top choice.

LIBREOFFICE

Move objects more precisely

You can use arrow keys to move an object, and the cursor to resize its frame, but the free PixelPosSize (PPS) extension for LibreOffice adds a pop-up window that lets you do both - with more precision.

Download it by visiting www.snipca.com/46803 then clicking 'Download latest'. In any LibreOffice program, click Tools then 'Extension Manager...'. Now click Add and find the PixelPosSize file you've just downloaded. Click 'Open' to add the extension. This will add PPS to your toolbar (1) in our screenshot below).

Once you've created an object, click PPS then select PixelPosSize (2) to open the controls. Use the arrows to move an object or change values in the X and Y categories. To resize an object, change the values in W and H. If you have multiple objects, click the navigation icon (3) to open the Drawpage Navigator (4). Here, you can view all elements in your document, and choose which you'd like to manipulate. Press the Esc key to close PixelPosSize.

MICROSOFT EXCEL

Combine data from several columns into one

When making a table, you may decide you want to combine data from two different columns into a new one. Rather than spending ages typing your text into a new cell, create a formula to do the job using the ampersand (&) operator.

In our example, we're putting together a guest list for a summer party. We want to combine first names from column A with surnames in column B. We want these to appear in column C, so we clicked in cell C4 and typed `=A4&" "&B4` (1) in our screenshot). The space between the quotation marks separates the two cells. This produces our first guests' full name in column C4 (2). If instead we wanted to list guests with their surnames first, we'd type `=B2&" "&A2`.

After typing the formula we selected C4 and tapped Ctrl+C. We then highlighted cells C5 to the bottom and pressed Ctrl+V to paste the formula into the whole of column C. ■

First name	Last name	Full name	Attending?
Liz	Akehurst	Liz Akehurst	Yes
Dan	Jones	Dan Jones	Yes
Jennifer	Jones	Jennifer Jones	Yes
Martin	Huxley	Martin Huxley	No
Steph	Barlowe	Steph Barlowe	No
Ali	Hart	Ali Hart	Yes
Jess	Di Stefano	Jess Di Stefano	Yes
Rita	Shah	Rita Shah	Yes
Bryony	Davis	Bryony Davis	Yes
Fatima	Habib	Fatima Habib	No
Eli	Hayes	Eli Hayes	Yes
John	Collymore	John Collymore	Yes
Yomi	Mawaki	Yomi Mawaki	Yes
James	O'Flaherty	James O'Flaherty	Yes
Brian	Teller	Brian Teller	Yes
Andrew	Akin	Andrew Akin	Yes
Lilly	Moore	Lilly Moore	Yes

ONLINE

Browser tips

Secret settings and best extensions

CHROME

Control the type of ads you see on websites

Despite a couple of delays, Google is still planning to phase out cookies in Chrome by the end of 2024 in favour of its own Topics system. Chrome 115, which was released 12 July, implements the first stage of Google's plan by adding new privacy settings that let you control (to some extent) the types of ads you see on web pages.

You may have seen a pop-up message about 'Enhanced ad privacy in Chrome' when you updated the browser. If not, you can access the new options by going to Settings then 'Privacy and security', and selecting 'Ads privacy'. If that option isn't listed, click Privacy

Sandbox, switch on Trials and restart the browser.

The 'Ads privacy' page comprises three options. The first, 'Ad topics' (1 in screenshot below), shows you personalised ads based on sites in your recent browsing history. Once turned on, it lists topics Google thinks you're interested in so that Chrome can display relevant ads. You can also block specific topics so you don't see ads related to them.

The second option, 'Site-suggested ads' (2), lets websites display ads based on your activity on them, while the third option, 'Ad measurement' (3), allows sites and advertisers to monitor the performance of their ads, such as the time of day you saw them.

Google believes Topics offers greater privacy than cookies because it groups you with other Chrome users who have the same interests, rather than building a profile of you and tracking you across the web. But until there's clearer information about the system, you may prefer to leave the new settings switched off.

Settings

Ads privacy

Ad topics

Ad topics

Based on your browsing history. This setting is off.

Site-suggested ads

Site-suggested ads

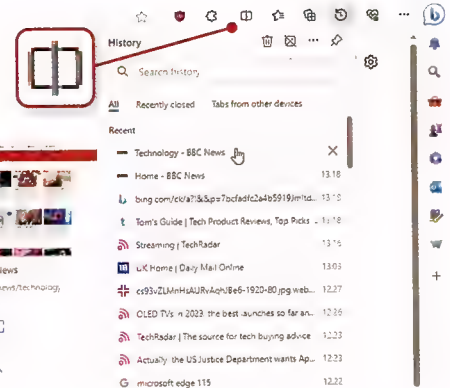
Based on your activity on a site. This setting is off.

Ad measurement

Ad measurement

Sites and advertisers can understand how ads perform. This setting is off.

Ad measurement



EDGE

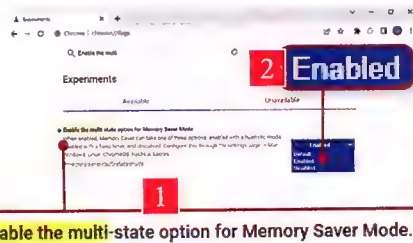
Preview pages in your browsing history

The History feature in most browsers is just a list of web pages you've previously visited, which doesn't tell you much about their actual content. Edge 115, which was released 20 July, introduces an enhanced History panel that displays thumbnail images of pages when you hover your cursor over them.

To try the new feature, open the browser's History by pressing Ctrl+H or clicking the three-dot menu button and selecting History. Hover your cursor over an entry and it should display a thumbnail preview of the page. If not, click the 'Turn on image on hover' icon at the top of the History panel (see screenshot above). We found that only pages added to our

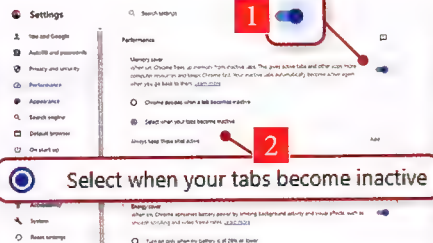
CHANGE THE INACTIVE TIME FOR CHROME'S 'MEMORY SAVER'

A new Chrome experiment lets you tweak the browser's 'Memory saver' feature to specify the length of time it waits before freeing up memory from inactive tabs. Here's how to try it.

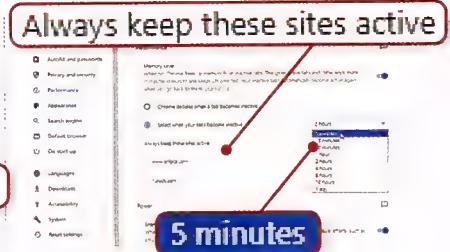


1 Enable the multi-state option for Memory Saver Mode.

1 Type chrome://flags into Chrome's address bar and press Enter to load the Experiments page. Find the entry Enable the multi-state option for Memory Saver Mode (1), select Enabled in its dropdown menu (2) and restart the browser.



2 When Chrome reopens, click the three-dot menu button and select Settings then Performance. Switch on the 'Memory saver' feature (1) if it's not already enabled and activate the option 'Select when your tabs become inactive' (2).



3 Specify how long Chrome should wait before freeing up memory from inactive tabs – from five minutes (1) to one day. To stop Chrome unloading specific sites, click Add next to 'Always keep these sites active' (2) and enter their URLs.

BEST EXTENSION FOR...

Wet weather warnings

RAIN ALARM

Chromium: www.snipca.com/46775

Firefox: www.snipca.com/46776

Australian summer means sudden and often heavy showers, but Rain Alarm can help you avoid a future soaking. It alerts you when rainfall is imminent in your location by displaying a pop-up notification and playing an optional stormy sound effect. You can change how often the extension checks the weather, the radius of the area it covers and the sensitivity of its rain alarms by right-clicking its toolbar button and choosing Options. When you left-click map. This

allows you to track the progress of rain clouds approaching your area, see how light or heavy the downpour is likely to be (see screenshot right) and decide whether you need to take an umbrella.

If you don't like that, try...

UV Weather

Chromium: www.snipca.com/46777

This excellent weather extension reserves some features for its paid-for version, but provides lots of useful information for free, including 'probability of precipitation'.



History after we updated to Edge 115 showed image previews – old entries merely displayed the page title and URL.

The new History panel also gives the 'Clear browsing data' option its own bin icon rather than tucking it away. This lets you delete your browsing history, cookies and cached data in a couple of clicks, as you can in DuckDuckGo's new browser.

To make your History easier to access, click the three-dot button in the top-right corner of the panel and choose 'Show history button in toolbar'.

FIREFOX

Stop Firefox blocking your favourite add-ons

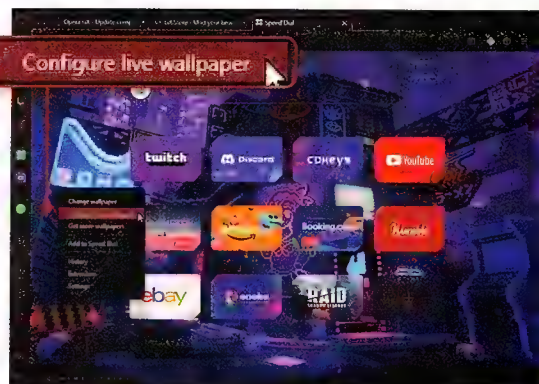
Firefox 115, which was released in early July, is the last version of the browser to support Windows 7 and 8. If you're using either of those operating systems, you'll soon need to upgrade to Windows 10 or 11, or switch to a browser that still supports them, such as Pale Moon (www.palemoon.org).

Another controversial change is that Firefox 115 will prevent some add-ons running on certain

websites. When this happens, an error message will appear in the Extensions (jigsaw-piece) panel to tell you that 'Only some extensions monitored by Mozilla are allowed on this site to protect your data'.

Mozilla says it has introduced this new feature, which it calls Quarantined Domains, for 'various reasons, including security concerns'. That sounds vaguely useful for protecting you against data theft, but it may result in your favourite add-ons being disabled on sites where you need them.

Quarantined Domains is still in development, but if you find it overzealous and are happy to risk using an extension that isn't monitored by Mozilla, you can disable it. Type `about:config` into Firefox's address bar, press Enter and click 'Accept the Risk and Continue'. Search for the preference `extensions.quarantinedDomains.enabled` and double-click it to change its value to 'false' (see screenshot below). Restart the browser to apply the change.



OPERA GX

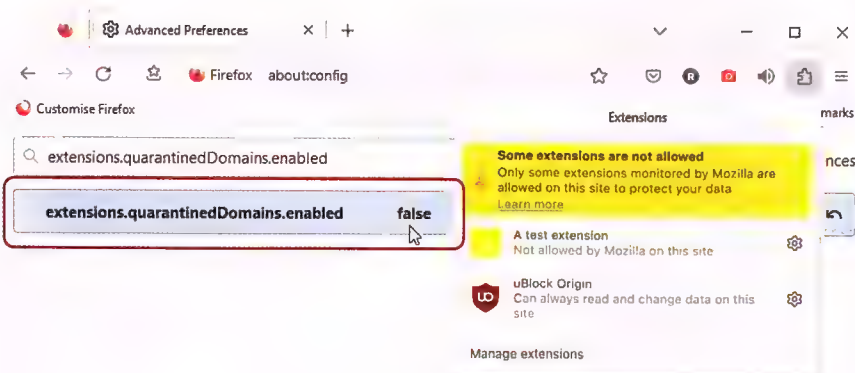
Play mini games in Live Wallpapers

Opera GX (www.snipca.com/46766), the browser designed for online gamers, now offers its own mini games through a new feature called Live Wallpapers. These are essentially interactive background images that respond to your mouse movements.

To try Live Wallpapers, either click the 'Take me there' button on Opera GX's homepage or go straight to www.snipca.com/46767. Here you'll see dozens of wallpapers with names like Arcade Alley, Sunset Flight and Veggie Slicer. Select one to learn more about it, then click Install.

When you open a new tab, your live wallpaper should appear as the background – if not, right-click the page and choose 'Change wallpaper'. You can also select 'Configure live wallpaper' (see screenshot above) to customise different aspects of the design, including the theme, camera angle and the behaviour of dynamic elements.

When you install Opera GX, make sure you click 'Configure in settings' and untick the boxes allowing Opera to collect your data and use it to show you personalised ads.



My vault
Joe
Nick+Toni

All items
Favorites 1
Trash

Login
Card
Identity
Secure note

Banking
Business
Email
Entertainment
Streaming
Games
Internet services

accounts.firefox.com
npeers@gmail.com
adobe.com
work@nickpeers.com
ancestry.co.uk
nickpeers
apple.com
work@nickpeers.com
Ebay.co.uk
nickdanp
google.com
npeers@gmail.com
login.live.com
nickdanp@hotmail.com
MoneySpire Cloud
nick@nickpeers.com
MoneySpire Cloud
musicmagpie.co.uk
nick@nickpeers.com
my.roku.com
nick@nickpeers.com
Plex
nick@nickpeers.com
server.support-pcs.co.uk
nickdanp
uk.webbuy.com
nick@nickpeers.com

Name
Ebay.co.uk
Username
nickdanp
Password
.....
Authenticator key (TOTP)

URI 1
https://signin.ebay.co.uk/ws/ebayisapi.dll?signin&ru=http%3a%2f%2fc

New URI

Folder

No folder

Favorite

Master password re-prompt

Attachments

1. ORGANISE LOGINS

There are various ways to organise your logins – by folder, type and by marking some as favourites.

2. FIND YOUR LOGIN

Logins matching the current view (or search terms) are shown here – simply select one to view it.

3. MAKE CHANGES

You can manually edit key details like the login's name and URL(s) – the websites it appears on.

4. STORE MORE DETAILS

You can set special conditions, plus attach more information – notes and custom text fields too.

MAC OS

Create strong passwords

Discover how to get started with Bitwarden's free password tool.

IT WILL TAKE
15 minutes

YOU WILL LEARN
To set up and use
Bitwarden on Safari

YOU'LL NEED
Bitwarden account
and app(s), macOS
10.14 or later, Safari



One password manager to rule them all. That's the dream, and Bitwarden is the reality! It's free and open source, works across your devices and has everything you'd normally find in an expensive alternative such as LastPass or 1Password. There is a Premium tier, but it's only \$10/year and no core

functionality is locked behind it. The free version works across all your computers, web browsers and mobile devices.

Bitwarden is easy to set up, can be integrated as your default password manager and, if you don't trust the cloud, you can even set up your own self-hosted instance.

First, sign up for a free account. Head over to bitwarden.com and click Get Started Today where you'll be prompted to register. You need to supply your email address, name and a master password. This will be the last password you need to remember, so it needs to be memorable, but not short or guessable. You can head to bitwarden.com/password-generator and use it to generate a 'passphrase' (three random words).

Accessing Bitwarden

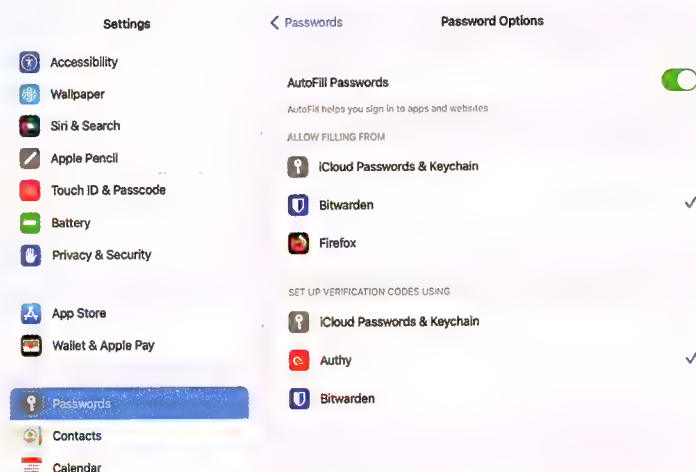
You can log into your vault through any web browser at vault.bitwarden.com, but a better bet is to install the desktop app (and Safari extension) from the Mac App Store. Other web browsers are also supported – visit bitwarden.com/downloads for direct links to these, plus don't forget to install the free iPhone and iPad apps too.

Nick Peers



GENIUS TIP!

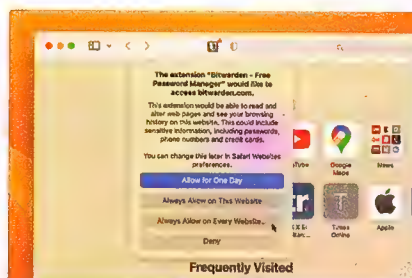
Make frequently accessed logons more visible by ticking the Favourite box when editing so they appear at the top of the list under Vault.



Once installed on your iPad or iPhone, head to Settings > Passwords > Password Options to make Bitwarden your default manager.

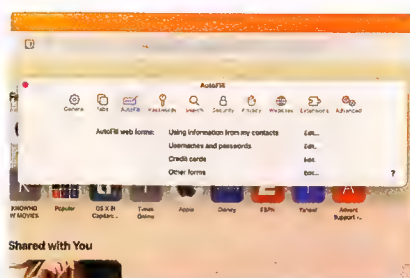
"Bitwarden is easy to set up, can be integrated as your default password manager and, if you don't trust the cloud, you can even set up your own self-hosted instance."

HOW TO USE BITWARDEN IN SAFARI



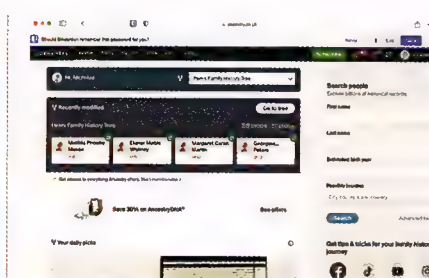
1 ENABLE SAFARI EXTENSION

After installing the desktop app, launch Safari and click Turn On Extension when prompted. Click the Bitwarden icon and choose 'Always Allow on Every Website' twice before clicking again to log into your account.



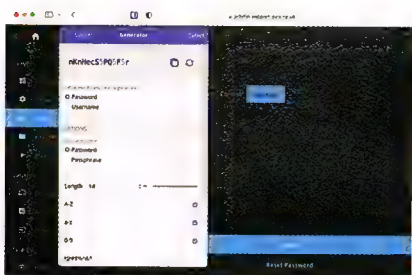
2 DISABLE AUTO-FILL

Open Safari > Preferences > AutoFill and untick all four entries as shown to disable Keychain. Bitwarden supports autofill, but note the warning under Settings > AutoFill; use the Cmd+Shift+L shortcut instead.



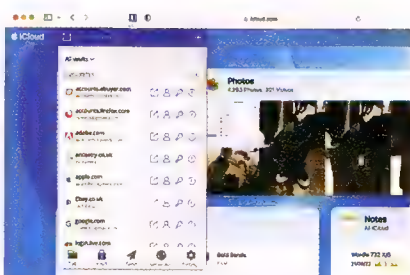
3 SAVE EXISTING PASSWORDS

When you next log into an existing account, Bitwarden should detect you've done so and offer to save the login details. Click Save – you'll see a small number appear above the Bitwarden icon indicating that it's been saved.



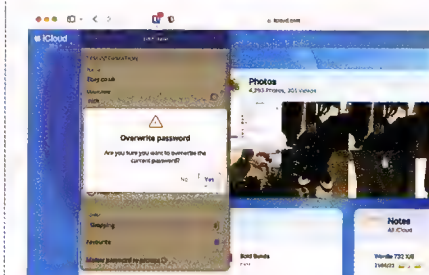
4 GENERATE PASSWORDS

When signing up for a new account, open Bitwarden and click 'Add a login'. Fill in the details (name, username), then click 'Generate password' followed by Select. Click Save followed by Ctrl+Shift+L to use it.



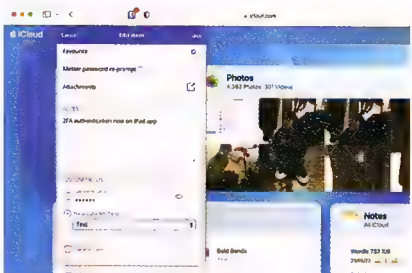
5 EDIT LOGIN INFO

You can edit your login info – say, after updating a password online. Open Bitwarden, locate your login details (click Vault or use the 'Search vault' tool if necessary), then click the View button followed by Edit.



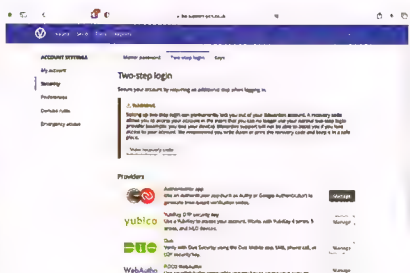
6 MAKE CHANGES

You can manually edit fields, or – in the case of the password – generate a new random one by clicking the button on the right. Click Yes to overwrite the current password, which will be kept under 'Password history'.



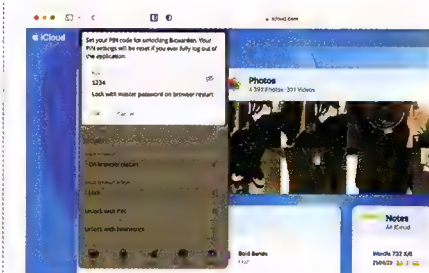
7 RECORD MORE INFO

Scroll down and you'll see space to record more information – there's a simple Notes field, plus you can add dedicated fields to store other info; choose Hidden to hide sensitive information. Click Save when done.



8 SECURE YOUR ACCOUNT

If your master password is leaked, anyone could gain access to your account. Log into vault.bitwarden.com and navigate to Account Settings > Security > 'Two-step login' to set up cation (2FA).



9 UNLOCK WITH PIN

Save time logging back into Bitwarden by unlocking the extension with a PIN: open Bitwarden, click Settings, tick 'Unlock with PIN' and enter a PIN code. Untick 'Lock with master password' only if your Mac is secure.

LINUX

Best kept secrets

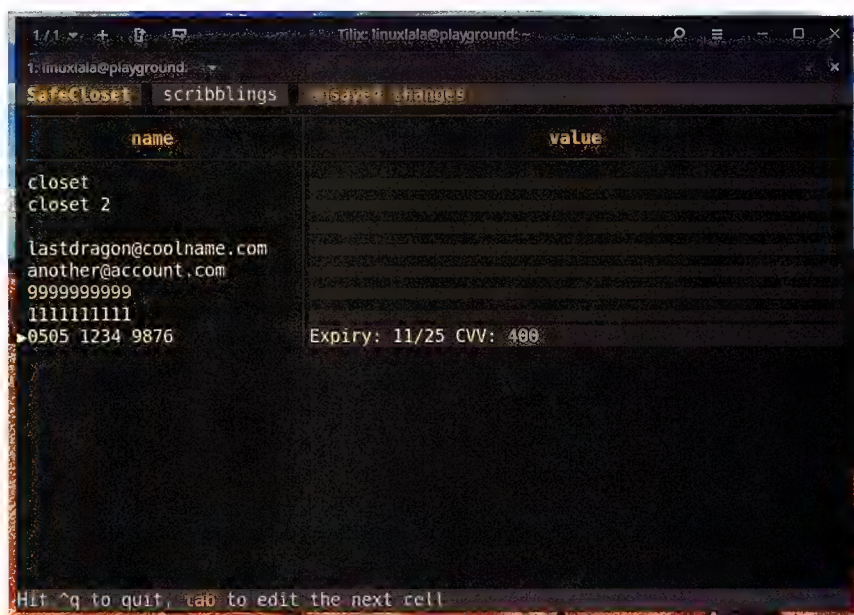
A man who keeps his cards close to his chest, we struggled to persuade Shashank Sharma to reveal how he protects his passwords.



Everybody's got something to hide except me and my monkey, said the Beatles back in the day. However, the correct phrase for the modern world would be, "Everybody's got something to hide, especially me and my monkey." If you're still keeping all your passwords and other important information in a draft email, SafeCloset is for you.

One of the first mistakes people make is using the same username and password combination across different online services because of their inability and unwillingness, understandably, to remember multiple login credentials. With SafeCloset, you can store all your different login credentials and other important information in secure, password-protected files. While there are many password managers on offer, some of them built into modern desktop browsers, the advantage of having all your secrets at your fingertips, rather than surrendered to the safety of a third party service, cannot be overstated.

You'll have to check the project's GitHub page or the website (<https://dystroy.org/safecloset>) for a complete list of features. For now, you'll appreciate that the project is cross-platform, which makes it possible for you to



While you can't use SafeCloset to secure files, you can secure any alpha-numeric data with it.

access your secrets from Windows, Mac and Android devices, in addition to all flavours of Linux.

Written in Rust and released under the AGPL-3 licence, the project isn't available in the software repositories of popular desktop distros. If you don't already have Rust and Cargo installed, you can use your distro's package

manager to install these: `sudo dnf install rust cargo` installs them on RPM-based distros such as Fedora. You can similarly run `sudo apt install cargo`, which also installs the Rustc package, if you're running Ubuntu or Debian, or a derivative.

You can now easily install SafeCloset from the source. First, clone the GitHub repository with `git clone https://github.com/Canop/safecloset.git`, then navigate into the `safecloset/` directory and run `cargo install --locked --path .`

Alternatively, you can download the ZIP file from the Releases section. This comprises multiple binaries – move the suitable `safecloset` binary to a directory in your `$PATH`. In our case, we moved the `build/x86_64-linux/safecloset` file to the `~/local/bin` directory.

Closets and their secrets

To begin using SafeCloset, you first have to create a closet. You can create as many closets as you like, but you have to create at least one drawer for each. The actual secrets, or information, are stored within such drawers. Both closets and their comprising drawers are password-protected.

SafeCloset also allows you to create nested drawers, but the official documentation warns against using drawers as categories. As all closets and drawers require individual

"One of the first mistakes people make is using the same username and password combination across different online services because of their inability and unwillingness, understandably, to remember multiple login credentials."

MIND YOUR DRAWERS

When adding entries to a drawer, you can press the Tab key after adding the value to create a new entry, or press Enter and then `n` to create a new entry in the current drawer.

SafeCloset's top bar is deliberately bare so you can see whether there are any unsaved changes in the drawer. To save a drawer, such as after creating a new entry, press `Ctrl+s`.

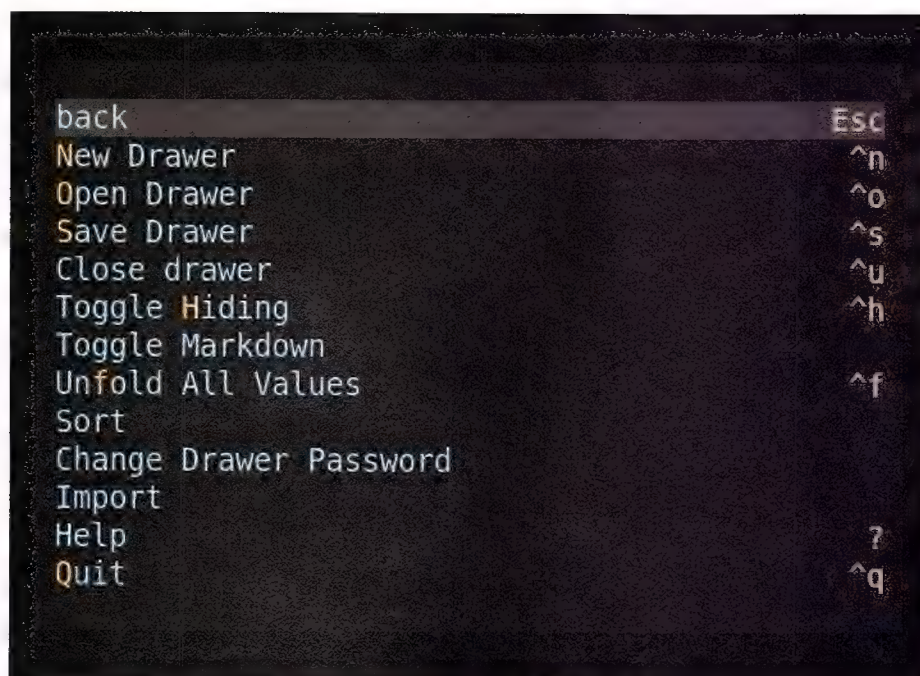
Press `Ctrl+u` to close the currently open drawer. SafeCloset automatically saves changes in the drawer before closing it.

If you need to edit any entry in your drawer, select it from the list and press `a`. You can reorder entries in a drawer using `Ctrl+Up Arrow` or `Ctrl+Down Arrow`. When

adding the value for an entry in a drawer, press `Alt+Enter` to create a new line.

You can also use the menu, which is accessed by pressing Esc, to select the operation you wish to perform, including changing the password for the drawer. It's also possible to import data from a drawer in the current closet or from a drawer in another closet.

SafeCloset will not create an empty closet file. So, in our example, the `~/Documents/scribblings` file is not created until after we create a drawer and save some new entries within it. It's good practice to copy this closet file and keep it as an added safety measure.



passwords, carefully examine your needs before creating closets and drawers.

You launch SafeCloset with `safecloset <directory>/<closetname>`. If the closet already exists, SafeCloset opens it, otherwise it creates a new one. For instance, the command `safecloset ~/Documents/scribbings` creates a closet called scribbings within the `~/Documents` directory.

When you create a new closet, SafeCloset informs you that this is a new closet and that you can press `Ctrl+n`, written as `^n` on the screen and in the project's documentation, to create a new drawer. You're asked to provide a passphrase for the new top-level drawer. You can choose any password of any length, or even opt for a passphrase if you so desire.

You'll notice the name of the closet on the top bar. SafeCloset doesn't allow you to provide names for the drawers, and the interface doesn't list how many drawers there are within any given closet. This is deliberate, to help protect your sensitive information. While you can provide any name you like for your closet, the project doesn't let you name the individual drawers within it. The drawers are only identified by the password or passphrase used to unlock them.

To open a drawer, press `Ctrl+o` and enter the passphrase or password you used to safeguard the drawer. If you have created

nested drawers, and wish to work with a deep-level drawer, you have to first open all the parent drawers.

With a drawer now open in the current closet, you can finally start relegating important information to SafeCloset. To begin, press `n`.

The SafeCloset interface now splits into two panes. On the left, you provide a name to identify the information you wish to store, and on the right pane the actual information to be safeguarded.

Name	Value
closet 2	Thisisthepassword
closet 3	When working with several closets
closet 4	Probably a good idea to store passwords in a secure closet
5	Passwords and passphrases can have spaces

By default, all the secrets, stored in the value field, are visible. You can press `Ctrl+h` to hide them. You navigate through the entries in a drawer using the up and down arrow keys. To view the associated secret for an entry in the drawer, press `Tab` and the hidden value is displayed, while values for other entries stay hidden.

If you want to always keep the passwords, passphrases and the values for the entries in a drawer hidden, you can start SafeCloset

As an added security feature, SafeCloset automatically closes after 120 seconds of inactivity.



GENIUS TIP!

If no `<path>` is provided to the `safecloset` command, the specified closet would be created in the current working directory. You can end up with multiple closets with the same name across different directories if you are not careful.

with the `-h` command switch. The command `safecloset ~/Documents/scribbings -h` opens the scribbings closet but the password you type to unlock the drawer and the actual values in the drawer are hidden.

Searching for answers

There's no limit to the number of entries you create within a drawer. If you end up with hundreds of entries in a closet, looking for information can be quite a pain.

Thankfully, SafeCloset offers a powerful search feature. Press `/` to invoke the search and type in the keywords to identify the entry you're interested in. To match entries in the drawer, SafeCloset looks only in the name field, not the value field. It also ignores case and diacritics when performing a search, so searches for `Twitter` and `twitter` yield the same result.

When multiple results are displayed, you can use the up and down arrow keys to navigate through the results and press `Enter` to select the one you want.

To access help, press `?` from the SafeCloset interface. This is quite thorough and covers all the options available to use within SafeCloset.

There's a number of operations only available from within a drawer, such as opening, creating, saving and closing a drawer, changing a drawer password, and so on. You can access all of these from a menu within the SafeCloset interface by pressing `Esc` from inside an open drawer.

To close a search, you must press `/` again and then `Esc`. If you directly press `Esc`, SafeCloset opens the menu instead of closing the search. To exit SafeCloset, select the option from the menu or press `Ctrl+q`.

Unlike most other text utilities, SafeCloset doesn't allow any operation or tweaking to be done by editing config files or using command options. Forcing users to perform all operations from within SafeCloset's TUI is yet another deliberate feature.

After having used a number of password managers over the years, this author can confidently state that SafeCloset is his favourite. ■

MOBILE DEVICES

Phone and tablet tips

Brilliant things to do on your device.

ANDROID & iOS

Chat to people who aren't contacts in WhatsApp



To start a new chat with someone in WhatsApp, you've previously needed to save their name and phone number as a contact. Although this makes it easy to identify their future messages, it also means your contacts list can become clogged up with the details of people you only

chatted to once or twice, and aren't likely to speak to again.

To overcome this problem, WhatsApp has added the welcome option to send a message to a mobile number without saving the person to your contacts. You can then delete or archive the conversation to keep your Chats list tidy.

Tap the 'Start new chat' speech-bubble icon to launch a chat, but instead of selecting a contact or creating a new one, type the phone number into the search box at the top of your screen. WhatsApp will tell you it's 'Looking outside your contacts' (see screenshot right) then let you begin the conversation.

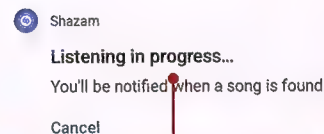
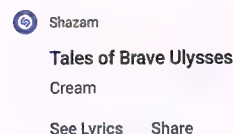
The new option also helps protect your privacy because the other person won't be able to see your profile picture, status or 'last seen and online' details, unless you have those settings set to Everyone rather than 'My contacts'. WhatsApp is rolling out the feature gradually, but it will be available to all users soon.

ANDROID & iOS

Identify songs on YouTube and TikTok



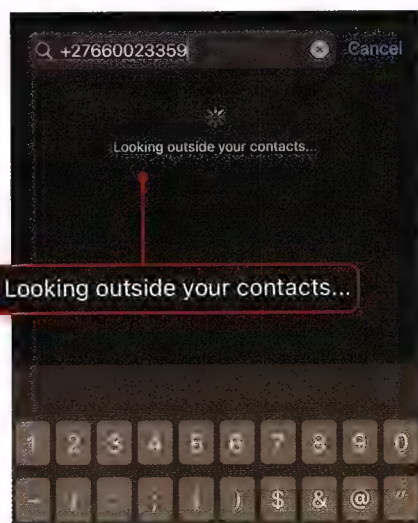
Apple's excellent music-discovery app Shazam has been updated for Android (tinyurl.com/APC525shaz/



APC525shaz) and iOS (tinyurl.com/APC525shazios) to identify songs in other apps on your device.

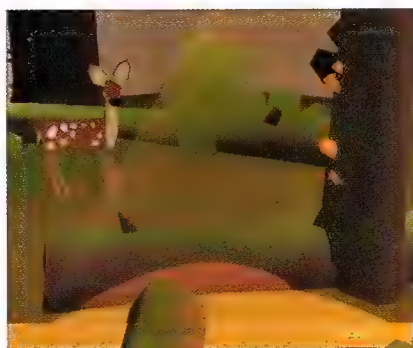
Previously, Shazam used the microphone on your phone or tablet to 'listen' for music playing near you, and tell you the name of the artist and track. Its expanded capabilities allow it to recognise songs in YouTube, TikTok and Instagram videos, which haven't been labelled with that information.

To use the new feature, open Shazam when playing music in one of those services, tap the 'S' button and switch



BEST NEW APPS

What you should install this month.

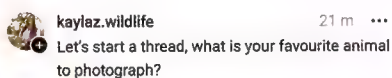


VIBES

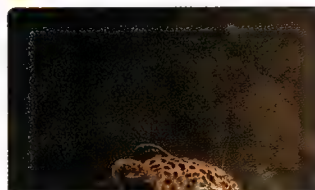
Free*

iOS tinyurl.com/APC525vib

This app lets you create personalised music to help you concentrate and relax, based on your daily activities and rhythms. Build a 'vibe' to reflect what you're doing, then listen to immersive soundscapes accompanied by colourful 3D animations you can interact with. It's beautifully designed and very therapeutic.



I'll go first, I'm loving leopards at the moment!

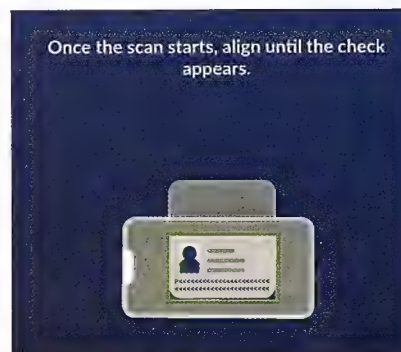


THREADS

Free

Android tinyurl.com/APC525thr

iOS tinyurl.com/APC525thrios
Meta's new Twitter rival has already attracted more than 100 million users, though you currently need an Instagram account to use it. Threads lets you post messages of up to 500 characters (compared with Twitter's 280), five-minute videos, photos, GIFs and more, and with friends and 'creators'.



ESTA MOBILE

Free*

Android tinyurl.com/APC525esta

iOS tinyurl.com/APC525estaos

Before visiting the US, it's essential to submit an Electronic System for Travel Authorisation (ESTA) application – and you can now do it on your mobile device using this US Customs and Border Protection app. It lets you start a new ESTA application, resume an existing one, scan your passport and pay the US\$22 fee.

*Contains in-app purchases

back to the relevant app. Shazam will then try to identify the track (see screenshot left) and – if successful – add it to your library and let you view the lyrics and share it. If identification fails, you can swipe down from the top of your screen and tap the option to try again.

Shazam has also added support for the Apple Music Classical app. This means that when you hear a classical track when out and about, or on one of the services mentioned above, you can open it directly in the Classical app.

iOS Add websites to your home screen in Chrome

Google is continuing to improve its Chrome browser for iPhones and iPads (tinyurl.com/APC525chr) by introducing the useful ability to add websites to your home screen. This feature, which is already available on Android, lets you tap a site's shortcut to open it instantly, without needing to launch Chrome first – effectively turning the website into a mobile app. These shortcuts also support notifications, so you'll receive an alert every time the site publishes a new article.

To use the new option, open a website in Chrome and tap the Share button in the top-right corner of the app. Select 'Add to Home Screen', edit the name of the site if you want, then tap Add. Chrome will automatically

fetch the website's favicon to represent the shortcut.

Note that your device needs to be running iOS/iPadOS 16.4 to use the new feature. Apple's Safari browser lets you add sites to your home screen in the same way.

ANDROID & iOS Find videos on Facebook more easily

Facebook has added new video features to its mobile app, to help it keep up with rival social-media apps YouTube, TikTok and its Meta stablemate Instagram. The 'Watch' tab has been renamed Video, and can be accessed via the top menu bar in the Android app (see screenshot below) and the bottom bar in the iOS app.

It brings together all Facebook's video content including Reels (which now last up to 90 seconds), longer clips and live streams, which you can swipe through vertically and filter using options such as 'For you', Live and Following.

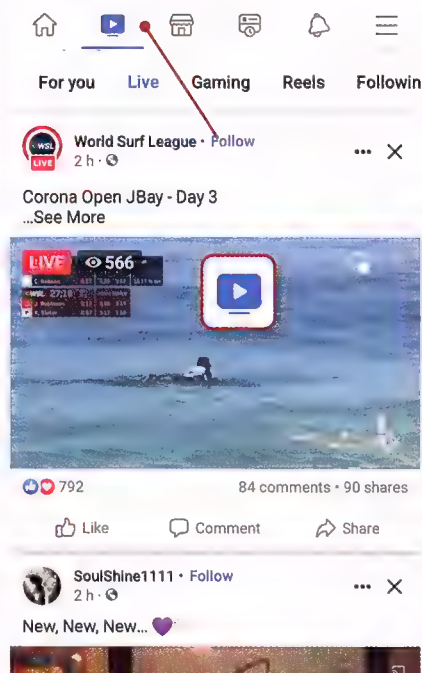
The search tool has also been updated to let you browse videos by topic (by tapping the relevant hashtags) and revisit videos you've previously watched.

ANDROID Balance the volume of YouTube videos

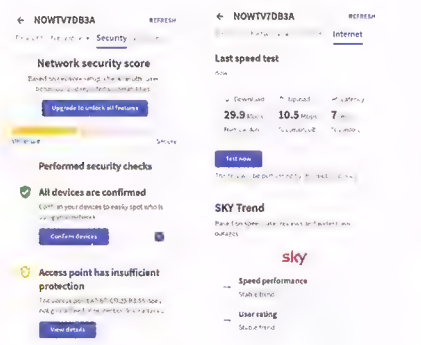
It's often difficult to get the volume right when watching YouTube videos, especially when you're listening through headphones, and the

transition from quiet dialogue to loud music and sound effects can be startling. You can now better balance the audio level by activating a new 'Stable volume' option in the YouTube mobile app (Android only, at the time of writing).

Tap the settings cog in the top-right corner of the video player and switch on 'Stable volume' (see screenshot left). This should normalise the sound in the clip to stop you jumping out of your skin when it suddenly gets louder.

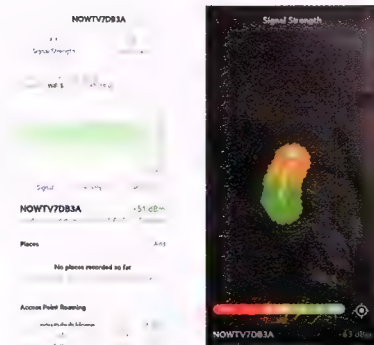


BEST APPS FOR Analysing your Wi-Fi network



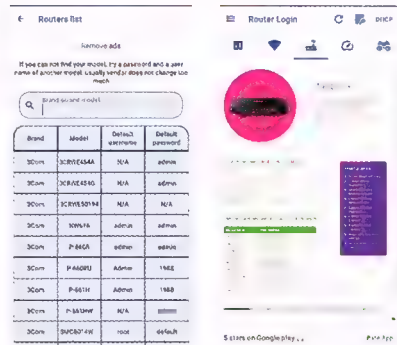
FING

Free* | Android tinyurl.com/APC525fing
iOS tinyurl.com/APC525fingios
Although Fing limits some of its best features to its subscription service, it's still an effective way to scan your Wi-Fi network for suspicious activity. It rates the overall security of your network, lists all the devices currently connected to it and lets you test your download and upload speeds to identify bandwidth hogs.
Best for checking your Wi-Fi security



WIFIMAN

Free
Android tinyurl.com/APC525wifi
iOS tinyurl.com/APC525wifiios
WiFiman provides a thorough scan of your Wi-Fi network to tell you the precise signal strength your mobile device is receiving, in dBm (decibel milliwatts). Walk around to check the signal quality in different areas of your home and even create a colour-coded heatmap to identify dead spots (Android only). **Best for testing your Wi-Fi signal**



ROUTER ADMIN SETUP

Free*
Android tinyurl.com/APC525rout
This app goes beyond providing information about your Wi-Fi speed and connected devices to let you tweak your router's settings too. Its long list of router models includes admin usernames and passwords, so you can sign into your device's settings and make changes. You need to pay to remove its ads.
Best for tweaking router settings

PI

Build a flashy dice roller with NeoPixels

Les Pounder is learning to multitask but we think he misunderstood the instructions.

YOU'LL NEED THIS

- Pi Pico/ Pico W
- TM1637 seven-segment display
- NeoPixel stick
- 9x M2M jumper wires
- Push button
- Half breadboard
- Code: tinyurl.com/APC525neo

The Raspberry Pi Pico is powered by a dual-core ARM CPU, and in this tutorial we will learn how to run two threads of MicroPython code independent of each other. The code in core 0 will wait for a user to press a button, and when they do, the code will choose a random number to emulate a D20 die roll. If the user is unsure what to do, a simple instruction will scroll across a seven-segment display, a TM1637 connected to the Raspberry Pi Pico using I2C.

The second core will run a light show, designed to entice the user to try our project. The light show is powered by a stick of WS2812B RGB LEDs, commonly known by the Adafruit brand of NeoPixels. These RGB LEDs require perfect timing in order to display the correct colour, so dedicating an entire CPU core to them means our number generator can get on with making random numbers. Both of these cores are running concurrently, and they can talk to each other, but for this tutorial we have intentionally kept it simple.

Build the hardware

The build is split into three sections. The input, a push button, is connected to GPIO16 and GND. The first output, the TM1637



The TM1637 seven-segment display module is a cheap and easy way to use the venerable displays without a mess of wires.

display, is connected to 3V, GND and two I2C pins (green GP27 and yellow GP26 wires), which provide the data connection from the Pico to the display. Lastly is an output for the NeoPixels. This uses any GND pin on the Pico, 3V, and GP15 is connected to Data In of the NeoPixels. Please refer to the high-resolution diagram in the download for more details.

Set up Thonny

While holding the BOOTSEL button, connect your Raspberry Pi Pico to your computer. Go to tinyurl.com/APC525python and download the version of MicroPython for your Pico or Pico

W. Open your file manager, go to the downloaded file and copy it to the root of the RPI-RP2 drive. This flashes the new firmware to the Pico.

Using your package manager, install Thonny. For the latest Ubuntu release, we have to use a Snap package:

```
$ sudo snap install thonny
```

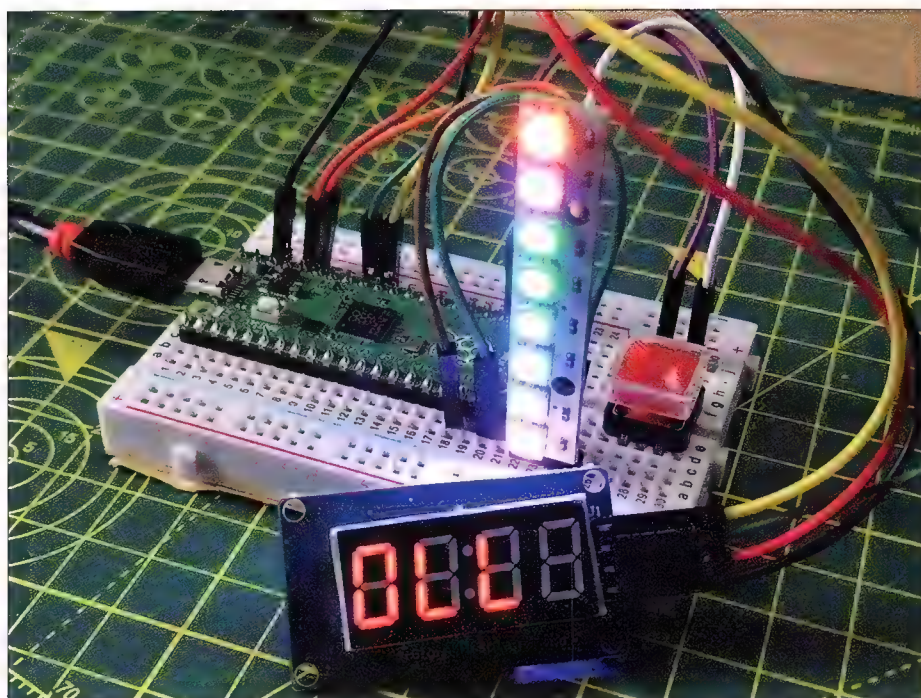
Open Thonny and connect the Pico to your machine. Go to Tools > Options and select the Interpreter tab. Set the interpreter to MicroPython (Raspberry Pi Pico) and set the Port to match the location of your Pico. Click OK. Thonny now connects to the board and we can start writing code.

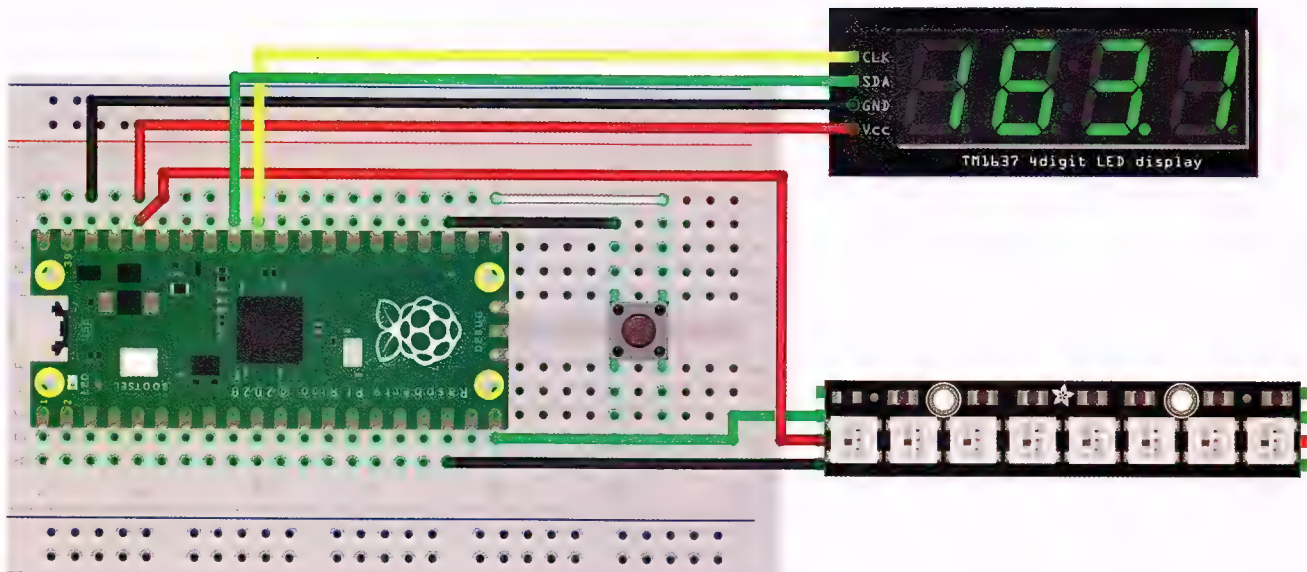
Coding the project

Create a new file and in there paste the contents of this link: tinyurl.com/APC525tm1637. The link is to Mcauser's excellent MicroPython TM1637 driver. Save this file to the root of the Raspberry Pi Pico as `tm1637.py`. Create a new file and visit this link: tinyurl.com/APC525neopixel. Copy and paste the code from the link into the new file. Save the file to the root of the Pico as `neopixel.py`. This link is to the `blaz-r pi_pico_neopixel` driver, which really simplifies using NeoPixels on the Pico. Close both of these files.

Create a new file and import a series of modules (libraries of code) starting with `Pin`, used to control the GPIO pins, and `tm1637`, to use our seven-segment display. Then import `randint` (random integers) from the `random` module, `sleep` from `utime`, `thread` (to create concurrently running threads of

Replacing dice with a light show and a random number generator, just to show off dual-core programming.





```
code) and Neopixel.
from machine import Pin
import tm1637
from random import randint
from time import sleep
import _thread
from neopixel import Neopixel
```

Next, we set up three objects to interface our code with the input (button) and outputs (TM1637 display and NeoPixels). Setting up the display involves calling the module and telling it the GPIO pins used to connect it. With the button, we tell the code where to find the button, and set the GPIO pin state to `PULL_UP`, in other words we pull the pin high (1) so that when the button is pressed, the circuit connects to GND. This causes the pin to pull low (0) and that change of state triggers the dice throw. Lastly, we set the NeoPixels to use an eight-LED stick, a state machine (0; it handles all the NeoPixel timings) and GPIO pin 15, and we set the pixels to use Green Red Blue configuration. You may need to tweak the GRB/RGB setting accordingly.

```
mydisplay = tm1637.TM1637(clk=Pin(26),
dio=Pin(27))
button = Pin(16, machine.Pin.IN, machine.
Pin.PULL_UP)
pixels = Neopixel(8, 0, 15, "GRB")
```

Next, we create a function to handle all the activity in core 0 of the Pico. We create a `while True` loop inside the function so the code is always running:

```
def core0_thread():
    while True:
```

Inside the function and the loop, create an if conditional test that checks for a button press. When it occurs, the code activates and triggers the display to blank and a message to be printed to the Python shell.

```
if not button.value():
    mydisplay.show("")
    print("Rolling")
```

Still inside the conditional test, use a for loop to run a pseudo random number generator that generates a random number between 1 and 20. Change this to match the die that you would like to use. Each time the for loop iterates, it flashes a number for 0.1 seconds before finally pausing for five seconds to show the generated result.

```
for i in range(10):
    mydisplay.number(randint(1,20))
    sleep(0.1)
    sleep(5)
```

If the button hasn't been pressed, the else condition activates and scrolls an instruction across the TM1637 seven-segment display.

```
else:
    mydisplay.scroll("Press to roll",
delay=200)
```

Now we create a new function for core 1 and again we use a `while True` loop.

```
def core1_thread():
    while True:
```

Inside the loop is a for loop; this time it iterates eight times to match the number of NeoPixels in our stick. This is so we have a seamless animation. Using the for

The circuit is made of three parts: an input (button) and two outputs (TM1637 and NeoPixels).

loop we create a variable, `i`, that starts at 0 and ends at 7. Each time the loop iterates, the NeoPixel at position `i` is updated with a random colour. We use `randint` to generate the value of each RGB value. We then use `show` to see the change before pausing for 0.1 seconds. The loop repeats until the Pico is powered off.

```
for i in range(8):
    pixels.set_pixel(i,((randint(1,254),
randint(1,254), randint(1,254))))
    pixels.show()
    sleep(0.1)
```

Now we start both threads so they run concurrently:

```
second_thread = _thread.start_new_
thread(core1_thread, ())
core0_thread()
```

Save the code as `dice_roller.py` and click Run (or the green Run button) to start the code. The TM1637 seven-segment display scrolls a message. Press and hold the push button until the number generation sequence begins. All the while, the NeoPixels are adding a little light show to entice the user to try out our new project. ■

PYTHON EDITORS

Writing Python or MicroPython is possible in any text editor: Vi, Nano, Geany, VS Code, Sublime Text and so on. It is totally up to you. But for Raspberry Pi users, the Pi team has provided what it sees as the ideal editor. Thonny (<https://thonny.org>) has been installed on Raspberry Pi OS for some time and for good reason: it is a great Python editor. Created by Aivar Annamaa, Thonny is a Python editor for newcomers and old pros. The user interface can be set to simple, removing many features that could confuse new users. But if you need the features, they can be enabled via Tools > Options.

Thonny works across Windows, Linux

and Mac OS, and with it we can write Python code for many devices. In the tutorial, we've written MicroPython for the Raspberry Pi Pico, but we can also write MicroPython for the ESP32, ESP8266, BBC Microbit and Lego EV3 control bricks. We can also use Tools > Manage Packages to install Python/MicroPython modules directly to the board. Thonny can also be used to write CircuitPython code, Adafruit's fork of MicroPython (itself a fork of Python 3 for microcontrollers).

We enjoy using Thonny — it has plenty of features for seasoned developers, but remains easy to use for those new to programming.

apc

EDITOR'S
CHOICE

GAMES

Baldur's Gate III

A dream RPG that was worth the 23-year wait.

\$89.95 | PC, PS5, XBS/X, Mac | baldursgate3.game

Baldur's Gate III is my dream game: the best parts of *Ultima*, *Baldur's Gate*, *Planescape: Torment*, *Arcanum: Of Steamworks and Divinity: Original Sin*. But it also does so much more than tap into the RPG greatest hits, finding a way to unite disparate philosophies like cinematic storytelling, unhinged sandbox mayhem and tabletop-style roleplaying.

And boy is it absolutely massive, as deep as it is wide. Each of the three acts could be their own epic RPG, jam-packed with elaborate dungeons, strikingly memorable quests and unique stakes, supported by systems that offer a huge amount of player freedom. It is a game overflowing with crossroads, with every step conjuring up yet more paths trying to seduce you off the beaten track.

Venture forth

The opening act sees you wrestling with the revelation that you've been infected with a parasite – a tadpole – that will eventually transform you into a monstrous mind flayer, stripping away your identity and free will as you become an agent of the Grand Design, attempting to bring about a universe where everyone is an evil squid monster. But that initial shock quickly makes way for a free-wheeling wilderness adventure

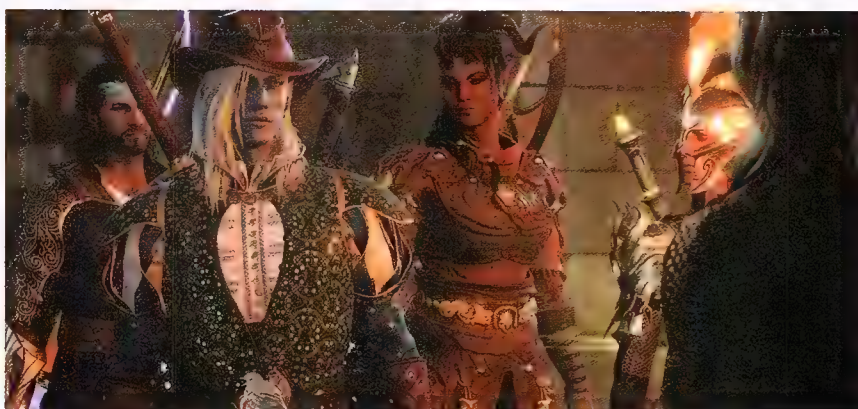
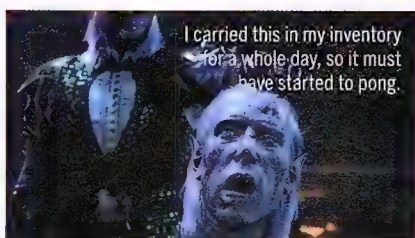
evocative of classic D&D escapades.

There's a druid grove in peril, goblins everywhere, a mysterious swamp and the opportunity to adopt an owlbear cub. Please do – it's adorable. It's here that you'll meet the majority of your companions, who share your mind flayer curse, letting you fill out your party to better tackle the dangers of the Sword Coast. This is *Baldur's Gate III* at its most traditional, but even so it pushes against the familiar, using things like the lurking danger – and allure – of the tadpole to keep you on your toes. It

bestows you with some of the powers of a mind flayer and encourages you to use them, manipulating your allies and enemies, with the promise of even more exotic powers.

With each act, there's not just a change in location but a change in tone as well. Act 2 has the most dramatic turn, with its shift into pure horror, all curses and twisted monsters and traumatised NPCs. There are shades of *Dark Souls* and *Bloodborne* here, laden with an oppressive atmosphere and some truly unsettling creature designs. It's a





welcome but harrowing change in direction.

Friends for life

The epic stakes are balanced out by the multitude of very intimate, personal stories – ones that are elevated by writing that never falls into the fantasy trap of becoming stiff or stuffy. The fate of the entire world hangs in the balance, but that's very much par for the course. Larian's writers make this matter by blessing the world with a bounty of rich characters who you'll become invested in as you spend hundreds of hours getting to know them.

Even though you have a great deal of control over what happens to your companions, they have a lot more agency than your usual RPG party members, including when it comes to romance, where they're usually the ones to instigate the change in your relationship. They have arguments and disagreements and agendas that are at odds with each other. And they never feel like they're just playing a supporting role. Their personal quests – each chock full of tragedy and conflict – are inextricably linked to the main quest, and every companion is treated as just as important as the player character. It's their story just as much as it's yours.

Anything goes

Baldur's Gate III fully embraces the flexible nature of D&D, turning it into an immersive sim where, if you can imagine it, you can probably do it. Every quest, puzzle and combat encounter has a ridiculous number of ways for you to tackle it, rewarding creativity at all times. Every time I thought, "It will never let me do this," I was proven wrong, with no cheesy tactic or exploitative loophole deemed out of bounds.

Spells, skills and physical manipulation of the world around you opens up so many doors, literally and metaphorically. You can make a fight against a trio of ogres go your way by smashing the rickety pillars holding up the building they're hanging out in, turn into a gas to sneak your way through tiny cracks in a wall, or use magic to persuade animals to turn on their masters. You might never talk to a single squirrel, but every animal in this humongous game has dialogue.

You can read minds, talk to the dead, create disguises, turn invisible and teleport yourself and allies across large distances, and these tricks can be used time and time again rather than just as one-off novelties.

Powergaming

The sheer number of magical items you'll encounter in your playthrough is enough to fill every shelf in Sorcerous Sundries, *Baldur's Gate*'s premier magical shop, a hundred times over. And many of them give you new spells and skills, completely changing your build. After finding a lot of lightning-themed gear I turned Gale into an invincible, electricity-spewing bomb who could just walk through the battlefield spitting out death while being completely immune to the fallout. He never left my side after that.

Embarking on this adventure can be pretty daunting, granted. D&D can be impenetrable for the uninitiated, and *Baldur's Gate III* is not an easy-going introduction to its rules and quirks. Even as a *Baldur's Gate* vet who also plays tabletop RPGs, I found it quite intimidating, and a lot of folk at PCG ended up starting the game again after 20 hours. It demands a lot of patience, then, and you might have to spend a lot of those early hours just figuring things out and muddling through. Once you've figured out D&D's eccentricities, though, you'll have a much better time.

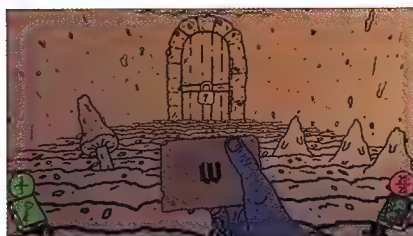
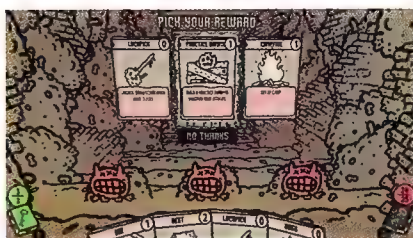
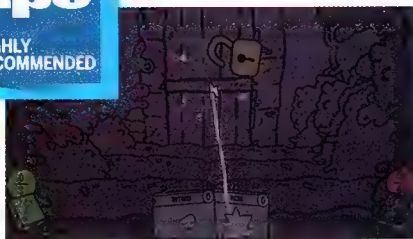
After reviewing a game this large, there's usually a sense of relief when I'm done. But not here. To be honest, I could have easily reached the game's climax days earlier, but I just couldn't bring myself to call it. I felt compelled to see as much as humanly possible in one playthrough because it's all just so bloody incredible. Whenever I found a new quest to distract me, I was overjoyed. Another reason to keep playing!

Baldur's Gate III is an unrivalled RPG that will swallow your life whole. And that's a good thing, it really is.

Fraser Brown

★★★★★

apc

HIGHLY
RECOMMENDED

SHROOM AND GLOOM

There's not mushroom for error.

■ Free | PC, Mac | bit.ly/ShroomGloom

Shroom and Gloom takes the deckbuilding roguelike and bungs in a big load of mushrooms. Your enemies are murderous fungus people, and most of the cards are mycology-themed. On top of that, it's all exquisitely hand-drawn. You know the basics by now: every turn you expend energy to play cards that are randomly drawn from your deck, while out of battle you plough through a dungeon, gradually acquiring shiny new cards.

The difference with *Shroom and Gloom* is that the dungeon is viewed from the first-person perspective, without the ability to sidestep or even go backwards. But exploration is neatly handled by the game's second deck of cards, which come into play in the safe rooms located between each combat encounter.

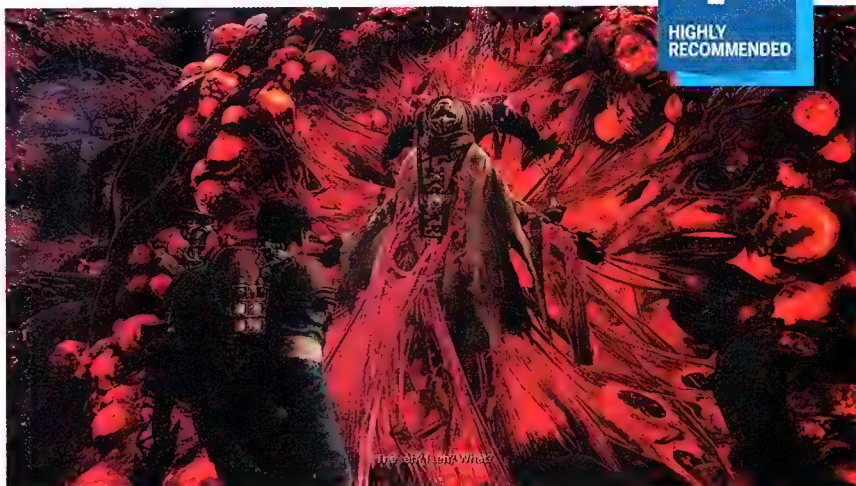
Similarly to the battle deck, these out-of-combat cards are randomly drawn each time you reach a safe room, and they do things like heal you up or improve one of your cards.

A compact card-based roguelike with a strong system at its core, a fresh perspective and an earthy theme.

Tom Sykes

★★★★☆

apc

HIGHLY
RECOMMENDED

REMNANT 2

Gunfire Games makes subverting expectations a habit.

■ \$73.50 | PC, PS5, XBS/X | remnantgame.com

I am a space ninja, carving up robot sentinels on an artificial planet stranded in time. A few hours ago, I was blasting cockney elves off a dilapidated clocktower with a gun that fires cubes. Before that, I was having my life drained by a cursed boardgame in an antechamber of a vast golden palace. Oh, and let's not forget the time I chased my friend through an ancient temple as he was dragged underground by a sentient tree.

If variety is the spice of life, then *Remnant 2* is a blazing hot videogame vindaloo. It can barely go half an hour without throwing some weird mystery box at your feet, and only half the time do its contents pop out to kill you. It's giving me exactly what I want from gaming, namely unique and exciting adventures with my pals that never rely on the numbers going up to keep me planted in my chair.

All these environments are procedurally generated, and *Remnant 2*'s maps felt unique and hand-crafted most of the time. Yet what impresses most is not how these spaces look, but how rewarding they are to explore. Each world has several 'main' areas which typically include two or three side dungeons. But every element is randomly assembled,

including the adventures you'll experience.

Behind *Remnant 2*'s surreal sightseeing tour is a thoroughly entertaining shooter. Mechanically, it gets the basics right. Movement is breezy but not weightless, the starting weapons are satisfying to wield, and your dodge-roll is nimble and has a generous invulnerability window.

More broadly, the way *Remnant 2* filters combat encounters into its procedurally generated levels impresses. Enemies attack from all angles, requiring you to be

constantly vigilant about your surroundings. But it isn't an endless, shapeless onslaught either. It ebbs and flows between tense and intense.

I might not take any unifying life lesson from *Remnant 2*, but there are a dozen smaller moments that'll be bouncing around my head for a good while, and that doesn't include the ones I haven't seen yet.

"If variety is the spice of life, then *Remnant 2* is a blazing hot videogame vindaloo."

Remnant 2 is a dependable looter shooter made special by its boundless capacity to surprise.

Rick Lane

★★★★☆



EN GUARD!

A brief yet riotous piece of swashbuckling nostalgia.

■ \$29.95 | PC | engarde-game.com

En Garde! is like the remaster of an early 2000s console effort that never existed, from a time when developers were figuring out how the scrolling beat-'em-up might evolve into three dimensions. Superficially, it bears a family resemblance to *Prince of Persia: The Sands of Time*, but it's narrower in scope, more cheap and cheerful.

Combat is where the difference really counts, though. Adalia understands that a good action scene doesn't merely entail swordplay, but acrobatics, pratfalls and an Ikea's worth of broken furniture. As much as she'll back herself in a one-on-one duel, guards don't queue up and wait their turn. Victories are thus earned by prancing around, using what comes to hand, until your swordswomanship can come to the fore.

Like Monty Python's Spanish Inquisition, in fact, your chief weapon here is surprise. Do something stylish or unexpected and an exclamation mark pops up over nearby enemies' heads. You might then get a free hit in, or use Adalia's boot to propel them into a wall, cracking their defences more

permanently. As for what causes surprise, well, quite a lot. Kick some boxes towards a group as they close in, perhaps, or chuck a jug at one of their heads, or a lantern at something explosive, or drop a chandelier when someone's standing beneath it.

It could do with a little more substance besides the combat, however. The *Prince of Persia* parallels also derive from Adalia's platforming acrobatics, for instance, as she swings on poles or bounces on hanging

nets to cross gaps, but nothing much comes of them. Getting from A to B is never more involving than spotting the next grab point and flinging yourself in its direction.

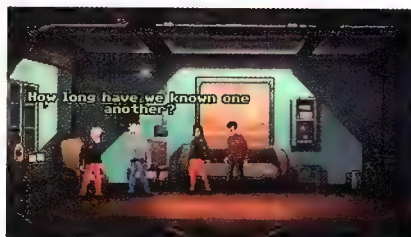
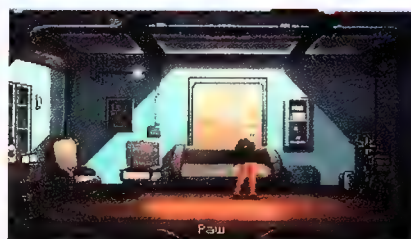
You might say that's all part of the nostalgia, but the whiff of vintage also makes *En Garde!* feel somewhat limited, a point driven home when you swashbuckle through it in under four hours, with only the prospect of doing it better to pull you back in.

"Like Monty Python's Spanish Inquisition, in fact, your chief weapon here is surprise."

En Garde! flares brightly with its slick, slapstick combat, for a while at least.

Jon Bailes

★★★★★



THE THIRD WISH

Monkey do in a sci-fi adventure game.

■ Free! PC, Mac, Linux | bit.ly/ThirdWish

The tale of the wish-granting monkey's paw is brought into the future in *The Third Wish*, a point-and-click made for the Adventure Game Jam.

You play as Mr White, whose family runs a moisture farm on a desert planet, a place where shrivelled monkey limbs are the furthest thing from his mind. A few traditional point-and-click puzzles later, an old trader friend appears and shares his story. He ends the night by discarding the monkey paw that has ruined his life – and telling you to destroy it.

It would be a happier, shorter game if you obeyed him, but after some cajoling from your family, you do indeed make three wishes with the paw. Inevitably it all turns paw-shaped, in a suitably ironic conclusion complete with a plummy, Rod Serling-esque voice-over.

The game begins and ends strongly, but it is uneven in the middle, when the traditional puzzle-solving of the early game is abruptly jettisoned. From then on it's a linear, contained story in which you occasionally select the dialogue.

An enjoyably hammy sci-fi story with lovely pixel art.

Tom Sykes

★★★★★





GAME CHANGER

Jet Set Radio

A vibrant Tokyo-like city with an anti-establishment attitude. By Matt Poskitt

■ Release: 2000 (2012 HD) Developer: Smilebit (BitWorks HD) Publisher: Sega Link: bit.ly/43FPQIQ

"Jet Set Radiooooooooo!" yells DJ Profesor K, as the title screen bursts into life with a remix worthy of Fatboy Slim himself. The cel-shaded action skater game with a Y2K aesthetic and a cool electronic, funk and hip-hop soundtrack – that is still dynamite to this day, might I add – is undergoing a bit of a resurgence as of late. This has all stemmed from the lead-up and launch of Bomb Rush Cyberfunk, a spiritual successor that looks to build upon everything that made the original so damn engrossing.

Not that *Jet Set Radio* needs a renaissance. The fanbase and ever-lasting admiration for Beat, Gum and the ever-growing GGs gang has prevailed for more than two decades now, something pretty special considering only two mainline console games were released in the early 2000s.

My own personal history

actually begins with *Jet Set Radio Future*, the 2002 sequel that somehow is still exclusive to the original Xbox. Seriously! It's never been made available anywhere else, with licensing issues surrounding the music being the prevailing theory about why.

I'll always remember when my father brought home a second-hand Xbox that was once owned by my cousins, and with it came the double game disc of *Sega GT 2002* and *Jet Set Radio Future*. Being as immersed as I was by the poppy visuals, anti-establishment empowerment and Tony Hawk-like soundtrack, it's sort of amazing I've never experienced the original release until now.

For those not in the know, the action arcade skate game is all about spraying graffiti across the three districts that make up the city of Tokyo-to. For the most

part, you need to tag around 20 or so marks within a time limit to progress, all while avoiding local law enforcement, rival gangs and, sometimes, deadly assassins. There are other levels where you need to spray paint a rival's back, alongside frequent opportunities to unlock new characters by racing to tag a graffiti spot first or by following in their slipstream perfectly. It's all wonderfully simple.

Fan longevity

I think that simplicity has contributed to *Jet Set Radio*'s longevity with fans. Within minutes, you know exactly what the rest of the game entails – and it never loses its charm, and never outstays its welcome, either. Eighteen missions to complete across three chapters, ranging between six to eight hours in gameplay, hits the sweet spot of



Right: DJ Professor K in da house!
Far Right: Exploring the city is half the fun.



what Jet Set Radio needs to be with enough replayability in pursuing the top rating (I'll get there one day) to keep you coming back for more. My playthrough was made possible via the 2012 HD port of *Jet Set Radio*, which was included as part of Sega's Heritage Collection series (available on Steam). It's clear that while the core concept holds up miraculously, some of Sega's original decisions and new 'improvements' to the port have not aged so well. For one, the camera. I can only assume the person documenting my skating

antics was a bit worse for wear, having to constantly battle with walls, staircases and anything else en route whenever I was trying to figure out where to head next. Where's Lakitu when you need him?

The most bizarre decision of them all is an exit. There I am, skating along, minding my own business – and suddenly, a big 'Exit' notice appears above me. Found at the end of certain unsuspecting streets, for no reason whatsoever, it caught me out early on, losing a good run in the progress. A mistake I never

made again. Still, it's the reasoning behind the inclusion I can't get over. We have a pause menu. Within that pause menu is an exit button. Surely that would make more sense than randomly placed exits. Look, I get it, I'm not a developer and the aim here is to simulate a city that appears never-ending, which does work to an extent. In spite of that, just put some orange cones down or use traffic to block the way out. It's frightfully easy to think the level continues around the next corner... oh wait, now I'm back in the main menu. Terrific.

This might only be topped by the decision to show a cutscene every time you escape the police. Every. Single. Time. The law enforcers are constantly chasing you. It's not like you can lose them and they're gone forever. Nope! It can literally be moments before they scurry back into frame and there it is again, a two-second cutscene of the police waving their truncheons in my direction like an episode of the *Three Stooges*. It's all very slapstick. I think there's an interesting way to implement this too, just without the need to

DISCOGRAPHY

A brief history of Jet Set Radio videogames



JET SET RADIO 2000

An action skate game where a group of young rollerbladers look to rule the streets of Tokyo-to by tagging graffiti.



JET SET RADIO FUTURE 2002

The sequel serves as a reimagining rather than a continuation, picking up with the GGs once again in a futuristic Tokyo.



JET GRIND RADIO 2003

A remake of the original Dreamcast title designed for the Game Boy Advance running on the *Tony Hawk's Pro Skater* engine.



Far left: The three districts that make up Tokyo-to.
Right: Graffiti puzzles require precision toggle movements.



constantly interrupt gameplay.

One thing that I kind of unironically love is the audio-dialogue overlay, both fighting it out to be heard through the airwaves. Was it this bad on the Dreamcast? Was this Christopher Nolan before he got into filmmaking? I don't know, but the chaos of it all made me smile. Except perhaps for some more variety when it comes to the toggle direction puzzles for spraying graffiti, there's really little else that needs changing.

Sure, the jagged edges of the cel-shaded art style might resemble elements of a rejected Picasso by today's standards. That in no way takes away from Jet Set Radio's overall sense of fun.

Forever young

Wanting to move away from the number of fantasy games on the market in the late '90s, while also having just shipped *Panzer Dragoon Saga* for the Sega Saturn, Masayoshi Kikuchi and Ryuta

Ueda moved onto *Jet Set Radio* as project lead and art director, respectively. This was a team said to be made up of fewer than 25 developers and with an average age of less than 25. Who says that youth is wasted on the young?

That wonderful sense of adolescence carries throughout *Jet Set Radio*, from the clothing to the vibrant streets to the use of music. Nothing embodies this more than the main titles' anthem 'Let Mom Sleep' from lead composer Hideki Naganuma. By taking the line of dialogue, "Would you stop playing with that radio, Lord? I'm trying to get to sleep!" from the 1950s BBC radio comedy, *Hancock's Half Hour*, starring Tony Hancock (also featuring various Carry On stars, such as Sid James, Hattie Jacques and Kenneth Williams) it's then remixed to a fast, modern beat. And cor blimey! Does it work!

This only continues with its use of licensed music, including hip-hop group Jurassic 5, Japanese underground indie rock band Guitar Vader and even a bit of Rob Zombie thrown in there for good measure. If I played this as a teenager, there is no doubt that I

CRYSTAL BALL *What the future holds*



While rumours do the rounds online of a new *Jet Set Radio* being in the works at Sega, August sees the release of *Bomb Rush Cyberfunk* by Dutch indie game studio Team Reptile. As a spiritual sequel to *Jet Set Radio*, this action-adventure platform game is described as "one second per second of advanced funkstyle". The main premise sees players explore the five boroughs of New Amsterdam as they battle rival crews and avoid militarised police.

Bomb Rush Cyberfunk is now available on Steam and Nintendo Switch.



would have downloaded each song individually to my MP3 player via LimeWire, and that really is the highest of accolades any of us can award.

What I like about the story is that it could easily be from an anime series, as influential businessman Gouji Rokkaku (voiced by Mario himself, Charles Martinet in the English version) seeks out a demon record to take over the world. It never distracts from the gameplay element, letting the characters shine instead. Beat and Gum may be the poster children, but goth girl Cube stole my heart, reminding me of an 18-month period when my wardrobe severely lacked any primary colours.

The real star, though, is DJ Professor K. Host of *Jet Set Radio's* "premier pirate radio station", the man behind the decks breaks down plot details in such a charismatic way that it's impossible to not be taken in by his magnetism and witty lyrics.

"It never loses its charm, and never outstays its welcome either"

Billy Brown of *How to Get Away with Murder* fame is the one behind the mic, delivering pearls of wisdom like, "Brush those teeth boys and girls because a whole lot of trouble is heading your way". He occasionally answers fan mail too, "We got a letter from Mr Owsaki. 'How do I get rid of those nasty roaches?' Easy. Burn your house down." Duly noted.

Ever-expanding

As one of the earliest games to feature an open 3D environment to explore, I appreciate how the city expands over the course of the narrative. Take Kogane-Cho for instance, where you start off in a residential area in one of the opening levels, returning time and time again to discover an expanded area, a construction site, and a whole sewer system to explore. It was only on my last visit that I realised these were interconnected and not separate – a huge accomplishment for the time.



And what really pulled me in from the beginning was the difficulty. There's no settling in, with a decent challenge presented from the first five minutes, peaking in one of the final levels – Fight or Flight – where jetpack enemies swarm like a hive of bees around every turn. After a few deaths, I stumbled across a Reddit thread only a few years old aptly titled "I hate this level".

Naturally, a lot of the locations featured are inspired by various settings across Tokyo, such as Shibuya and Shinjuku's shopping districts. Bantam Street, on the other hand, is based on parts of south Bronx from New York City. Moreover, it's the only place where a death of a character occurs, potentially pointing to gang violence in America. Or maybe I'm reading too much into this. It's an interesting decision that happens unceremoniously offscreen and is never really touched upon again, for better or worse. Was this really the intention of Sega and Smilebit? Well, to pull some further words of wisdom from the amazing DJ Professor K, "On the streets, there's no such thing as 'The End.'" ■



Back to BASIC: learning IT the old-school way

David Crookes reveals how retro computers are still teaching kids a thing or two – and why their history is worth studying.

Educator Gary McNab vividly recalls a brief conversation he recently had with a four-year-old pupil. "I was visiting a primary school and he turned to me and said, 'Gary, have you come from the 1980s?'" Yet the question wasn't entirely bizarre.

McNab was attending the school armed with a bunch of computers from that decade along with other machines from the 1970s to the 1990s. "I replied to him, 'yes, I've come back to the future in my Sinclair C5'," he laughed. And the response contained more than a grain of truth.

"His work entails delivering workshops in schools in which he shares memories of what it was like growing up in an era when home computing was no longer a pipe dream."

McNab is no time-traveller (or at least we don't think he is), but he has been bringing the past to life under the banner of The Code Show. This an organisation he set up with the aim of introducing a new generation of children to computing history.

His work entails delivering workshops in schools in which he shares memories of what it was like growing up in an era when home computing was no longer a pipe dream. He also explains how the machines helped to bring about technological, social and cultural change and he uses them

Above: Chuckie Egg continues to delight today's children.

to teach vital skills such as coding and design.

All of this, he told APC, is not only going down a storm with pupils, it's filling a hole in school curriculums. "I feel it's crucially important for children to understand not only our history as a nation but how technology has evolved," he said.

"Currently, in history lessons, children learn about the Egyptians and the pyramids, the Romans and their roads, the Victorians and the industrial revolution and the Edwardians and the aeroplane. Yet we make no mention of the information age or the social and cultural revolution that the computer has brought." McNab is determined to change that.

Teacher's PET

The idea for The Code Show emerged after McNab attended some retro gaming events – most notably Play Expo, which has been staged in large venues across the country since 2012.

He saw how older, obsolete computers were capable of engaging not just nostalgic adults but fresh young minds. As the computing coordinator and educator for a primary school in Lancashire, he looked into ways of educating his pupils about the past, and raised the idea of taking them to the Centre for Computing History in Cambridge.

"Unfortunately, the logistics proved to be unworkable, with the distance and the cost of coaches and so on," he said. "I thought if I can't do it, then other schools can't do it either, so I ended up doing something myself." After taking a selection of computers into his school, he staged what proved to be a very successful taster session. "I'm now travelling all over the country," he added.

Contrary to what he told his questioner, McNab doesn't really take to the road in a Sinclair C5, although he does take one with him to show pupils. "The Code Show is just me, my passion for computing and a van loaded with machines – the Sinclair C5 helps children understand that electric transport is not a new invention," he explained.

He'll arrive at a school at 7am and spend a couple of hours setting up as many as 18 different computers. These are picked from a vast collection of 200 machines which include the Commodore PET, Commodore VIC-20 and Commodore 64, as well as the Sinclair ZX81, BBC Micro, Acorn Electron, Amstrad CPC 464, Oric-1 and the Amiga.

All are operational and they're ready to be played with from 9am. "I'll then run one-hour workshops throughout the day giving children a brief introduction to the machines before getting them to code and play some of the games," McNab said. "We usually have a class of 30 but we have had as many as 60 per session depending on the school. We also have lots of excited teachers recalling their youth."

For added interest, McNab takes along other technology such as LCD handheld games, a Sinclair flat screen television and a Rubik's cube. "We also have a table from

the 1980s of items which would now fit in a mobile phone as an app – for example, a portable video camera, video recorder, traditional camera, a Sony Walkman, boombox music cassette tapes, laser discs and traditional vinyl LPs," McNab explained.

Such items help to create a compelling environment that piques the curiosity of children and encourages them to learn. "I also introduce a mechanical typewriter, which proves to be very popular with everyone," he continued. "Children have grown up with computers and screens so they're fascinated by the novelty of printing directly on paper using technology that no longer exists."

Skills gap

Hands-on learning is at the heart of each session. "My mission is for children to have hands-on access to everything that we bring into school," McNab said. It has enabled kids to learn how computers work and how different machines tended to have different operating systems.

They also get to experience different methods of storage, including cassettes, floppy disks and cartridges. When switching from 8-bit to 16-bit computers, they can also begin to understand how the move from command line interfaces to graphical user interfaces helped to open up computing to a greater number of people.

In many ways, The Code Show harks back to the days of the BBC Computer Literacy Project (clp.bbcrewind.co.uk), which aimed to introduce a whole generation of children to computing between 1982 and 1989.

The initiative centred around the BBC Micro computer and a host of television programmes supported by books and other learning material. The difference now is that computing is well established, so The Code Show is focusing more on where we've been rather than where we're going.

That said, The Code Show also taps into the trend over the past decade to move computing studies past merely teaching children how to use apps and more on how to create their own. For so many years, kids were only being taught how to get to grips with word processors and spreadsheets. They weren't exploring what was going



on under the hood of their machines.

To help address that, the BBC attempted a second Computer Literacy Project in 2012, coming shortly after an e-Skills study discovered the GCSE ICT course was "so harmful, boring and/or irrelevant it should simply be scrapped". The then education secretary Michael Gove sought to give teachers freedom over what and how to teach, hoping that it would better prepare children to work at the forefront of technological change. But that brought problems of its own.

"When Computer Science was introduced into the National Curriculum, it's fair to say there was a panic among teachers over how they were going to teach it," McNab recalled. "I remember thinking and having conversations with teachers saying it wasn't new; that what we were being asked to do mirrored what we were doing in the 1980s. The Code Show demonstrates how we as children started to learn

BBC BASIC, written by Sophie Wilson, included an inline assembler.



The Amstrad CPC 6128 came with a very helpful manual.



coding and how technology continues to evolve."

Play time

It seems counter-intuitive that the machines of the past could help equip children to work with the machines of the future, but McNab is convinced they can. The sheer curiosity value of displaying old computers and gadgets helps to attract a child's attention. The trick is to then retain that attention so that they begin to learn, even if they don't always realise it.

The Code Show appears to achieve this by introducing kids to games from yesteryear. Although some parents still see videogames as distractions, McNab spies an opportunity. "The children love playing the likes of *Manic Miner*, *Chuckie Egg*, *International Soccer* and *Donkey Kong*," he said.

"Everyone comments on how hard the games are yet everyone returns to play again because ultimately they want to succeed. It's a good mindset to have; a reminder that the best part of making mistakes is the ability to fix it and that's a superpower! They're playing games, relating to them – many look at the graphics of *International Soccer* on the Commodore 64 and call it 'Minecraft Football' – and they want to keep going.

"I will often ask the teachers if they would give their class a copy of *Super Mario Bros* and see if they can complete three levels over the weekend. I guarantee that 98% of the class will complete the task but if you give the pupils traditional homework, you'd struggle to get that many."

Manual labour

It's not simply an exercise in perseverance. It's a way of showing how games once were, and children will be able to make their own comparisons to the



videogames of today. They will pick up on how retro games were designed and how programmers made good use of older machines.

"Learning about computing history allows children to gain a deeper understanding of the limitations of the time, and it also shows how people using older machines had to use their imagination, be resilient and develop a problem-solving mentality," McNab said.

They can draw upon this knowledge in their coding sessions which gets kids to dabble with BASIC – a programming language whose roots extend back to 1964. BASIC was hugely popular in the 1980s and it allowed scores of developers to develop core skills (the language has been the catalyst of many a high-profile career).

McNab argues it's better than the simple programming language Scratch, which is now routinely taught in schools, for the simple reason that connecting blocks like a jigsaw puzzle doesn't go far enough.

"Each computer I put on display has its own user manual, and I tell the children that it explains how they can communicate with the machine," McNab said. "We'll then start by entering traditional basic commands (10 PRINT 'Hello world'; 20 GOTO 10; RUN) and I will ask the children if Scratch would enable them to do that.

Top: Kids try out a Commodore PET, one of the first mass-market computers.

Above: Expert help is on hand to ensure children can make sense of it all.

Games are used to engage kids. In *Lemmings*, there's a bit of puzzle-solving to be had, too.

"The children will often tell me that they focus on the colours within Scratch, with each colour being a different command or operative, rather than focus on the text within the colour. Providing children with the opportunity to code in BASIC with a user manual gives them a solid understanding of programming and the natural progression and sequence of learning."

Children are encouraged to make their way through computer manuals or enter type-in listings from old computer magazines such as *Your Computer* and *Crash*. "They're learning just like we did in the 1980s when everything was trial and error," McNab continued. "Every child shows their resilience and they find typing in BASIC is fun because they can see their code execute on the 'run' command, which gives them a sense of achievement."

Children also appear to see the benefit of using written, printed instructions. "When I talk to children and teachers, Scratch doesn't seem to be as accessible, perhaps because there is no readily available printed learning manual – unless you print one yourself. There's something to be said for having a physical book in your hand and learning at your own pace."

Girl power!

A key part of the classes is ensuring that girls are as engaged in the workshops as boys. McNab has worked in STEM (Science, Technology, Engineering and Mathematics) industries since he left school ("my working background is in aerospace both





Who could resist a ride in a Sinclair C5?

civil and military”) so he knows more than anyone that they can be wrongly seen as solely a pursuit for men.

He addresses this issue right from the start. “In an assembly in the morning, I’ll ask the boys three questions: who was the first man on the moon, what was the famous quote Neil Armstrong says as he steps on to the moon’s surface; and who was the girl that put man on the moon?”

“They usually answer the first two but get to question three and fall silent. So I talk about the software engineer Margaret Hamilton and the code she wrote for the on-board flight software of NASA’s Apollo program. I then turn to the girls and say that’s girl power!”

“Forget the Spice Girls, Blackpink, Taylor Swift and Dua Lipa – the ability to problem-solve and think logically should not be underestimated and we should be celebrating women’s roles in computing. We need to get girls excited about science, technology, engineering and maths, and it’s great when they come into a workshop, sit down and look around. You can see them thinking logically about what’s happening around them and by the time they get access to the machines, they’re engaging.”

It’s this kind of success that motivates McNab who, prior to the Covid pandemic, was so immersed in The Code Show that he began to reduce his teaching days to focus on it. He was able to get back on the road again from March 2022, but the biggest challenge is school budgets – the costs of The Code

Show can be prohibitive for some.

Since the venture is entirely funded by McNab, it puts him in a frustrating position. While he’s still been able to visit more than 40 schools over the past year, he would like to see more investment from the wider computing industry.

“My ultimate wish is for Google, Microsoft, Fujitsu and the other blue-chip companies to take a look at what I’m doing in schools and perhaps sit down and provide funding so that I can take it to even more pupils without having to rely on school budgets,” he said.

“I have proven that the concept is sound and is attracting lots of interest, but I just want to visit more schools and hook kids into computing so that we can prepare more of our children for the world around them.”

He wants to see computing sitting alongside English, maths and science as a core subject. He also wants to ensure that computing history forms a part of that, proudly pointing out that Britain once had more computers in people’s homes than anywhere else in the world.

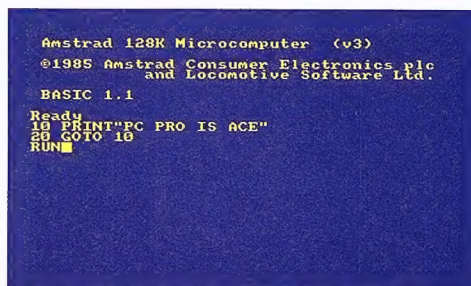
“If I can get the government and the Department of Education to sit up, take notice and embed this recent living history into the National Curriculum, we can give children a greater depth of understanding around the subject area,” he said. “Kids need to learn about the revolution which the home computer brought the masses. The demand from schools proves that history could be the missing part of the computing curriculum.”

CLASS ACTS!

Meet the three Cs of a retro computing education.

CODING

Many older computers allow users to get to grips with BASIC – or Beginner’s All-purpose Symbolic Instruction Code. Invented by mathematicians John G Kemeny and Thomas E Kurtz of Dartmouth College in Hanover, New Hampshire, it’s easy to use thanks to having commands that are similar to English and straightforward syntax. Ideal for teaching code structure, logical thinking and problem-solving skills.



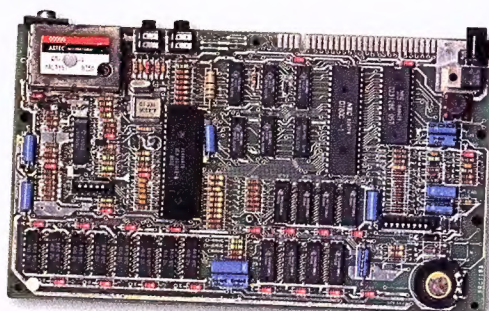
CREATIVITY

The limitations of retro computers can be frustrating but they still encourage users to think creatively. Whether you’re working with a small palette in an 8-bit paint program, creating text adventure games using software such as The Quill, immersing yourself in new worlds using the 3D Construction Kit or trying to create music out of blips and beeps, you invariably end up using your imagination.

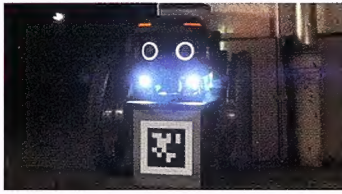


CLASSICS

Retro computers are steeped in history, and you get a sense of that just by tapping away at one. Aside from giving users a clearer idea of how the various components of a computer interact, they show how engineers came up with different operating systems and concepts. There are many fascinating stories behind those machines, too.



© YouTube, Ascento

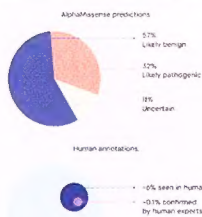


AUTOMATED ROBOT GUARD LOOKS LIKE IT COULD DOUBLE AS A BABY-SITTER

IT'S ABOUT AS INTIMIDATING AS A CLOWN ON A UNICYCLE.

Weaponised AI-powered robots like modified SPOT quadrupeds would undeniably make for intimidating computerised guard dogs, but we're not sure the wide eyed patrolling security robot from Ascento Guard is really up to the task of solving any global supply issues for security guards... at least not on its own. Looking like a cross between a Pixar character and your nerdy neighbour's Segway, this two wheeled sentinel isn't exactly the Jason Statham of autonomous robots, but it does at least have thermal, infra-red and regular cameras to detect any nefarious behaviour, and alert the true muscle.

All possible 72 million human missense variants



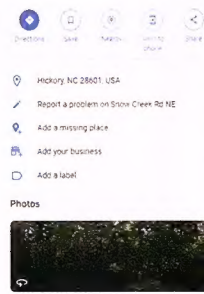
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DEEPMIND CAN NOW PREDICT GENETIC DISEASES

THIS BLACK-BOX GENIE KNOWS GENES.

AI has already proven itself to be adept at predicting the full gamut of protein structures nature can make thanks to the AlphaFold program, but a new DeepMind tool is making it possible to predict whether common DNA mutations are likely to be harmful or not. AlphaMissense, as the name may suggest, makes inferences about the impact of particular missense mutations in the A, C, G and T nucleotides that make up the DNA code. These mutations are not uncommon and most are harmless, but some are known to cause cystic fibrosis, cancer and sickle-cell anaemia.

Snow Creek Rd NE



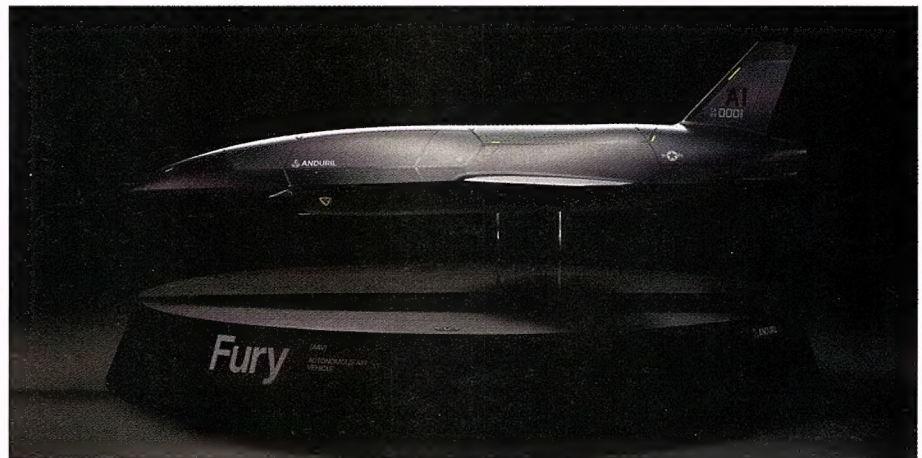
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CHIP CHAT

Google sued after Maps directed driver off a cliff

Talk about a bum steer.

A lawsuit filed in the North Carolina Superior Court in September accuses Google Maps of gross negligence, following an incident in 2022 where the software directed a driver over a bridge that had collapsed back in 2013. Philip Paxson, a 47-year-old father of two, was driving home from his daughter's ninth birthday in Hickory, North Carolina, when he drove his Jeep Gladiator off the end of the road and into a six metre deep ravine, subsequently drowning in the river below. The lawsuit alleges Paxton was following Maps' directions, having only recently moved to the area from Florida, down a privately owned road with no barricades in low visibility conditions.

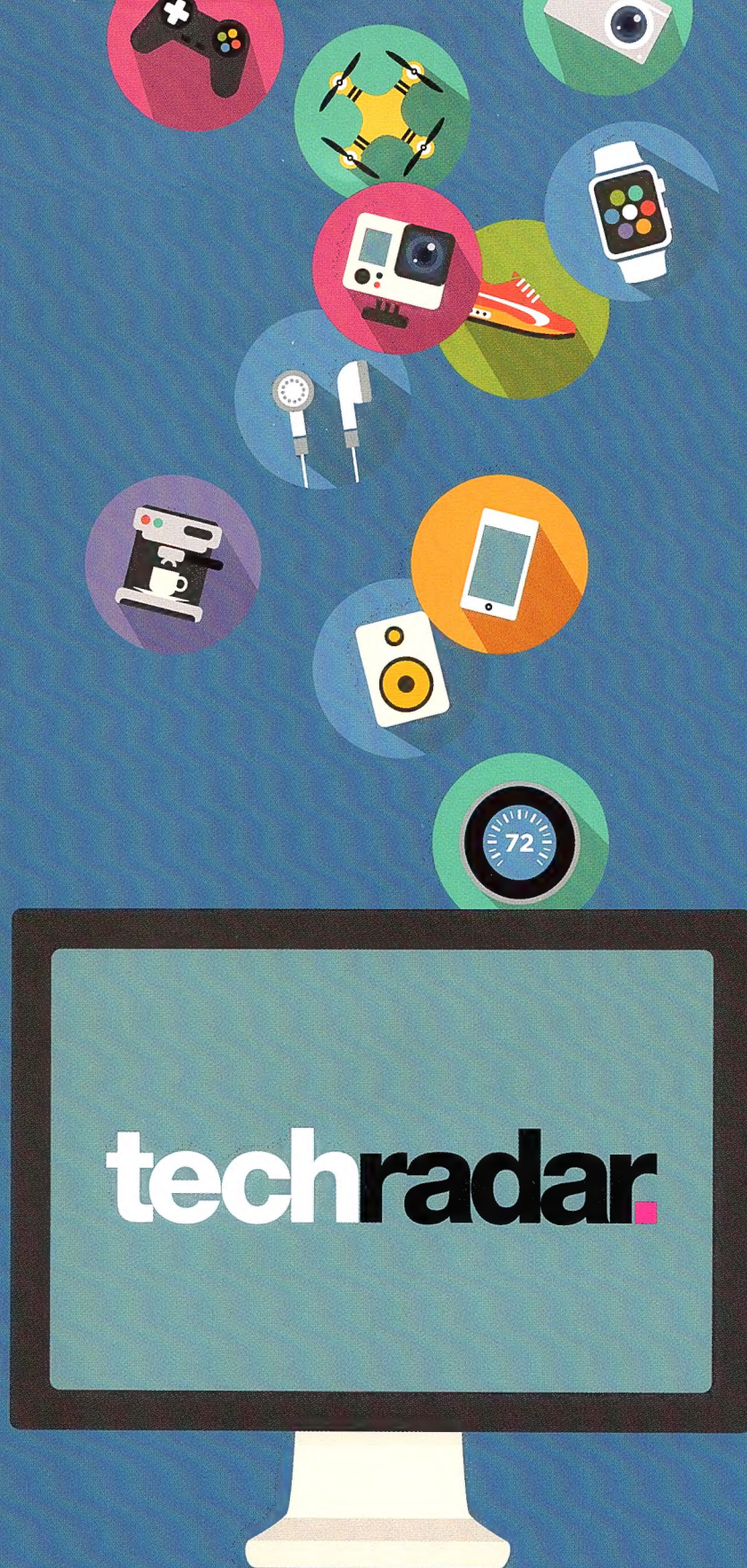


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PALMER LUCKEY ANNOUNCES LETHAL AI JET FIGHTER

ChatGPT drives AI weapons interest from US politicians and defence.

The 'daddy' of modern VR, sole inventor of lethal VR and controversial political activist Palmer Luckey, has unveiled his latest death toy that he hopes to sell to the Pentagon. The Fury, an autonomous jet powered drone designed to fly with F-35 fighter jets and B21 stealth bombers, is the most recent release from Luckey's post-Oculus defence startup: Anduril. The Fury was designed by Blue Force Technologies, a company that Anduril recently acquired with the intention of adding Anduril's proprietary AI flight tech to it. Lucky has been boasting in interviews about how the hype around ChatGPT means that AI defence tech is now basically selling itself. ■



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